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Industrial Machinery Noise Impact Modeling
Volume I

Bolt Beranek and Newman, Inc.
Canoga Park, CA

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July 1981

Noise

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BBN REPORT 4535

INDUSTRIAL MACHINERY NOISE IMPACT MODELING - VOL. I

July 1981

BBN Project 09635
EPA Contract 68-01-5892

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Participating Foundries, the identity of which will remain anonymous

EXECUTIVE SUMMARY

This study describes the development of a machinery noise computer model which may be used to assess the effect of occupational noise on the health and welfare of industrial workers. The purpose of the model is to provide EPA with the methodology to evaluate the personnel noise problem, to identify the equipment types responsible for the exposure and to assess the potential benefits of a given noise control action. Due to its flexibility in design and application, the model and supportive computer program can be used by other federal agencies, state governments, labor and industry as an aid in the development of noise abatement programs.

The model is developed based on the Level Weighted Population (LWP), and the fractional impact method used by EPA to assess occupational and environmental noise situations. To provide a comparison with the EPA evaluation, a parallel model based on the Occupational Safety and Health Act (OSHA) noise regulation administrated by DOL has also been developed.

The parametric design of the computer model allows the user to assess the noise exposure problem in several plants, an industry or a group of industries. Industry data are organized by Standard Industrial Codes (SIC) and the analysis can be performed by simply identifying a two-, three- or four-digit code depending on the detail required. Specific procedures for field data acquisition are provided. Additional data can be added to the existing data bank as it becomes available.

The end result of the evaluation is a rankordering of the machinery items which most contribute to the noise exposure problem in each industry. Furthermore, the effect of any noise control action on a specific equipment item can be quickly evaluated.

The accuracy of the results improves as the number of plants in the sample is increased. As an example of the use of the model two industries were surveyed; the Sawmill Industry and the Iron & Steel Foundry Industry. The sample size was nine plants for the sawmill industry and seven plants for the foundry industry. The accuracy of the results obtained using these limited sample sizes is discussed in the text.

Recommendations for the inclusion of an iteration procedure for the determination of minimum noise reduction requirements and the corresponding probable costs are also presented.

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Section 1
INTRODUCTION

1.1 Background

The effects of occupational noise on the health and welfare of industrial workers has been the subject of much debate in the past few years. Many industrial nations have recognized noise as one of the most serious and widespread health hazards in the workplace. Certainly, the most significant impact caused by long term exposure to high noise levels is the potential for hearing loss. It is estimated that 2.9 million workers in the U.S. today [1]* are exposed to a time weighted average sound level in excess of 90 dB and an additional 2.3 million are exposed to levels in excess of 85 dB.

However, the effects of industrial generated noise are not limited to hearing loss only. To the worker this hazard also means interference with speech communication (and thus possibly with job safety) and may be responsible for some physiological and work performance effects currently under study.

In response to this hazard, the Occupational Safety and Health Act of 1970, which is administered by the Department of Labor's Occupational Safety and Health Administration (OSHA), has imposed strict limits as to the maximum allowable noise exposure for employees. The OSHA noise standard is currently undergoing a review process that may result in still stricter limits.

In exercising its authority, the OSHA noise standard limits the total noise exposure of personnel during the workday (rather than any machine noise emission level) by the use of administrative or engineering methods or by personnel hearing protective devices when the preceding two are found not feasible (see Chapter 2). Compliance is tested at the individual plant level with the plant owner being responsible for remedial action.

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* Numbers in [ ] indicate references.

A second Act promulgated by Congress is the Noise Control Act of 1972 as amended by the Quiet Community Act of 1978. This Act gives the Environmental Protection Agency (EPA) the authority to promulgate regulations applicable to the manufacture of noisy products. Here the occupational noise problem is addressed through the reduction of equipment noise emissions by the equipment manufacturer rather than the equipment user. Though their approaches differ, the objectives of both OSHA and EPA noise legislation are similar: to reduce the hazard of noise to people.

To date, the thrust of the EPA noise regulations has been directed towards protecting the health and welfare of the general public from environmental noise sources. Major areas of interest have been transportation and construction machinery sources. Additionally, the EPA has developed the basis for voluntary noise emissions labeling programs and a mandatory labeling program for hearing protectors.

With respect to noise generated hearing loss, EPA has developed criteria relating hearing loss to noise exposure [2,3,4], identified levels requisite to protect health and welfare [5], and sponsored research on noise-induced hearing loss [6,7]. EPA has also studied national patterns in compensation for hearing loss [8], assessed the state of research and research needs for noise control of industrial machinery [9,10] and participated in the process of developing federal policies and revisions in the current OSHA regulation.

1.2 Objective

The objective of this program is to develop an industrial impact model that may be used by EPA to evaluate industrial noise exposure problems, to identify the equipment types responsible for the exposure and to assess the potential benefits of various noise control actions. To accomplish this, models using the EPA occupational noise criterion have been developed. A parallel model using the OSHA noise regulation was also formulated to allow for comparisons between the two agencies. Due to its flexibility in design and application the model and supportive computer program can be used by other federal agencies, state governments, labor and industry as an aid in occupational noise evaluations and development of noise abatement programs.

1.3 Organization

This report is organized as follows: Section 2 discusses the criteria used, both EPA and OSHA, and their basic differences. Section 3 presents an overview of the mathematical models used to calculate personnel noise exposure and to assess the machinery noise problem. Section 4 discusses the data acquisition procedures necessary to collect the input information used in the models.

Section 5 contains the results of the analysis conducted for the two industries surveyed under this program; the Sawmill and Planer Mill Industry and the Foundry Industry. Section 6 is an assessment of the errors inherent in the size of the data samples acquired. Section 7 contains recommendations for future research. Finally, a number of Appendices are included to support the results and conclusions presented in the report.

Section 2
CRITERIA

The identification of machinery responsible for hearing loss and the assessment of the degree it contributes to the noise exposure problem cannot be made without a proper set of criteria as a basis of evaluation. The original intent of this program was to use the EPA-established method through the calculation of the fractional impact. It was later decided that a comparison between the EPA method and the existing/proposed OSHA noise standard would also be desirable. Therefore, both the EPA and OSHA criteria methods are discussed here. A comparison between the two methods is also provided.

2.1 EPA Noise Impact Assessment

The impact of a noise environment on people regularly experiencing that environment is the degree to which the noise interferes with various activities such as speech, sleep, etc. - and the degree to which it may impair health, for example, through the inducement of hearing loss. The impact of a particular noise environment is a function of both sound level and the size of the population experiencing a particular value of sound level. EPA has established a method that can be used to assess a particular noise exposure through the calculation of the fractional impact. In terms of hearing loss considerations (occupational noise exposure), EPA has adopted the 8-hour equivalent sound level, $L_{eq}(8)$ to describe the physical phenomena.

In the "Levels Document" [2], EPA identifies an $L_{eq}(8)$ of 75 dBA as the criterion to protect against hearing loss. Various graduations of impact are then defined for levels exceeding these limits.

It is desirable to derive a single number that represents quantitatively the integrated effect of "impact" of the noise on the total population experiencing different sound levels. This single number quantification is the Level-Weighted Population, (LWP).

Level-Weighted Population is a single-number representation of the significance of a noise environment to the exposed population. Several assumptions are made in this method of analysis:

1. Intensity of human response to an average sound level can be characterized by several functions; the appropriate function being dependent upon the response mode of interest (annoyance, speech interference, hearing loss).

2. The impact of high noise levels on a small number of people is equivalent to the impact of lower noise levels on a larger number of people in an overall evaluation. Thus the properties of intensity (level of sound) and extensity (number of people affected by the sound) can be combined mathematically.

3. On the basis of these two assumptions one can assign differing numerical degrees of impact to different segments of the population of concern, depending on average sound level.

The preceding concepts have been embodied into a descriptive term called the fractional impact method. In this method, the fractional impact is the product of a sound level weighting value and the number of people exposed to a specified sound level. Summing the fractional impacts over an entire population provides the Level-Weighted Population.

That is, LWP is defined as:

$$LWP = \int P(L_X).W(L_X).d(L_X)$$

where $P(L_X)$ is the population distribution function, $W(L_X)$ is the sound level weighting function characterizing the severity of the impact as a function of sound level described below, and $d(L_X)$ is the differential change in sound level. L_X represents $L_{eq}(8)$ for hearing loss effects.

It is usually not necessary to use the integral form to compute LWP. Sufficient accuracy is usually obtained by taking average values of the weighting function between equal decibel increments, from 1 to 5 decibels in size, and replacing the integrals by summations of successive increments in average sound level.

Different weighting functions are provided for use in the analysis of environmental noise impact for hearing damage. In those specialized environments where people are directly exposed on a regular, continuing, long-term basis to 8-hour average sound levels [$L_{eq}(8)$] above 75 decibels, there is a potential for producing noise-induced loss of hearing and other severe health effects. The weighting function for loss of hearing/severe health effects, is expressed as:

$$W(L_{eq}(8))_h = 0.025\ (L_{eq}(8) - 75)^2.$$

The above method of evaluating impact was adapted to the problem of equipment noise and its effect on the working population, and is described more fully in Section 3.

2.2 OSHA Noise Regulation

Early Federal legislation on occupational noise standards was contained in the Walsh Healey Public Contracts Act under Section

50-204.10. The recent Occupational Safety and Health Standards contained under Section 1910.95 of the Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA) sets essentially the same noise exposure limits proposed by the Walsh Healey regulations, however, their applicability extends to all businesses.

In the next few pages, the occupational noise exposure regulations under Section 1910.95 of the 1970 OSHA are presented. It should be noted that at this time, a revised occupational noise exposure regulation has been proposed by DOL. The proposed modifications were published by OSHA in the Federal Register (37773) on October 24, 1974. The hearing conservation portion of the revised regulation was published in the Federal Register on 16 January, 1981, to be effective on 15 April, 1981. However, further DOL review has postponed the implementation date.

The occupational noise exposure regulations, essentially as they appear in Section 1910.95 of the Williams-Steiger Occupational Safety and Health Act of 1970, specify that protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table 2-1 when measured on the "A-scale" of a standard sound level meter at slow response.

The relationship between sound level and time shown in Table 2-1 can be expressed in equation forms as:

$$T_j = 8/2^{(L_j-90)/5} \qquad (2\text{-}1)$$

where L_j is the sound pressure level measured at the operator position j and T_j indicates the total time of exposure permitted at the level L_j. For the case when the Daily Noise Dose (DND) is composed of two or more periods of noise exposure to different levels, their combined effect should be considered as follows:

$$\text{Daily Noise Dose (DND)} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \cdots + \frac{C_N}{T_N} \qquad (2\text{-}2)$$

where C_j indicates the actual time of exposure at level L_j.

Table 2-1 Permissible Noise Exposure

Duration per day, hour	Sound Level Slow Response dBA
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

When the addition of the fractional noise exposures, $\left(\frac{C_j}{T_j}\right)$, or the Daily Noise Dose exceeds unity, the personnel noise exposure is above the permissible level.

Essentially the above computation methods identify the following important factors:

1. Noise levels above 90 dBA are potential hearing hazards. 90 dBA is the maximum allowable exposure for the 8-hour work day and also represents the threshold of noise. That is, noise levels below 90 dBA are not considered to be contributing to exposure.

2. The exchange rate between level and time of exposure is 5 dBA. That is, for each halving of exposure time, the allowable noise level may be increased by 5 dBA (i.e., 95 dBA for 4 hrs.; 100 dBA for 2 hrs., etc.).

3. When multiple exposures to different noise levels exist during the work day, the Daily Noise Dose is computed by adding fractional exposures.

2.3 EPA and OSHA Criterion Comparisons

Unlike the OSHA noise regulation which, based on the personnel noise exposure, establishes strict limits that must not be exceeded, the EPA criterion is based on the calculation of a fractional impact which then is used to compute the LWP. Thus, while the OSHA regulation results in the establishment of a compliance/non-compliance situation on an individual worker basis, the EPA criterion assesses the degree of noise impact associated with a population group.

The differences between the two spawn from the basic principles underlining the development of each criterion. The OSHA noise regulations were established to limit the extent of occupational hearing loss. It is assumed that the 90 dBA-8 hour criterion will protect approximately 80% of the working population from the hearing loss hazard. The EPA noise impact assessment on the other hand was developed to protect the public health and welfare with an adequate margin of safety. The main differences between the two are:

1. OSHA establishes a threshold level of 90 dBA. Noise levels below that value do not contribute to exposure. EPA does not implicitly have a threshold level but instead specifies the $L_{eq}(8)$ = 75 dBA as the 8 hrs. exposure level below which no impact exists.

2. The exchange between level and time is different between the two methods; 3 dBA for EPA and 5 dBA for OSHA.

3. Both methods provide for the accumulation of exposure over an 8-hour period.

4. While the OSHA method compares each individual exposure to a specific criterion the EPA noise exposure method ($L_{eq}(8)$) uses that data as a first step in the calculation of the fractional noise impact and subsequently in the computation of the LWP for a population group.

Section 3
NOISE EXPOSURE MODELS

This section presents an overview of two general models that will be used to quantify the noise exposure problem in industrial plants and discusses the data base requirements necessary to utilize them. One of the models is developed using EPA criterion and the other is developed using OSHA criterion. Comparison of results derived using each of the two models is left for another part of this report.

The need for a noise exposure model stems from the fact that personnel noise exposure is a complex quantity which requires the understanding of a number of variables, not all of which are associated with noise measurements. For example it is necessary not only to know the noise level of a given item of equipment at the operator position, but also the amount of time each day that a person in a given category spends using it and the relative amount it contributes to the background noise level of nearby personnel. In addition it is necessary to provide some means of allowing variations in noise level output for different items of equipment of the same type and variations in the amount of time personnel in the same category are assigned to particular items of equipment.

The objectives of the noise exposure models described here are as follows:

1. To quantify and rank order the impact of industrial noise environments on various personnel categories in a given industrial plant.

2. To quantify and rank order the importance of various equipment categories to the overexposure problem in a given industrial plant.

3. To include variability in noise levels for machines of the same type and variability in personnel work assignments for the same personnel category in order to deduce a "worst case" situation.

4. To extend the results derived from sampling several plants in a given industry to the entire industry and to establish confidence limits on these results.

5. To identify industries with the largest noise impact and to identify equipment sound sources which most warrant EPA regulatory or labeling actions.

A flow diagram for both the EPA and OSHA models is depicted on Figure 3-1. The data inputs required, components of the model and data outputs are presented in terms of this flow diagram.

3.1 Data Base Requirements

The data base requirements for each industrial plant considered are the same for each model and are as follows:

1. Equipment and background noise data.
2. Personnel work assignments[2]

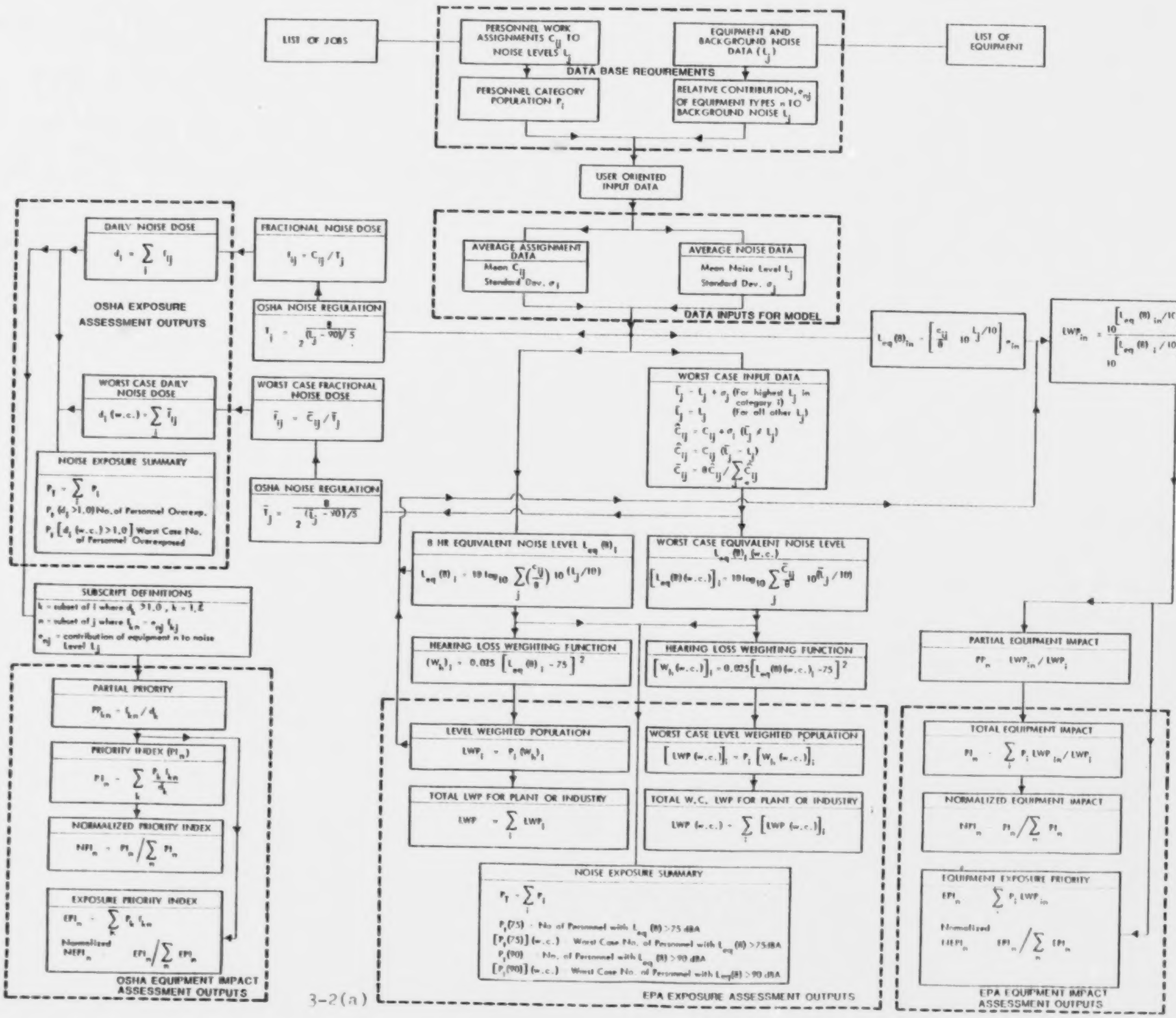
---

[2] There are two supportive requirements designed to more easily identify, measure and organize the basic data base. These are: a) List of Jobs and, b) List of Equipment.

The "list of jobs" is a list containing the job category identification code (2-digit SIC code + 3-digit job code) followed by a general 20 letter description of the job. One line is included for each job category identified.

The "list of equipment" contains a 4-digit equipment code unique to a given equipment type, followed by a description of the equipment and other details such as type, size, age, etc. The detailed requirements for this list and the list of jobs are discussed in Section 4 and in Appendix B of this report and will not be discussed further here.

FIGURE 3-1. FLOW DIAGRAM FOR NOISE EXPOSURE COMPUTER MODEL


LIST OF JOBS
PERSONNEL WORK ASSIGNMENTS C_{ij} TO NOISE LEVELS L_j
EQUIPMENT AND BACKGROUND NOISE DATA (L_j)
LIST OF EQUIPMENT
DATA BASE REQUIREMENTS
PERSONNEL CATEGORY POPULATION P_i
RELATIVE CONTRIBUTION, e_{nj} OF EQUIPMENT TYPES n TO BACKGROUND NOISE L_j
USER ORIENTED INPUT DATA
AVERAGE ASSIGNMENT DATA
Mean C_{ij}
Standard Dev. σ_i
AVERAGE NOISE DATA
Mean Noise Level L_j
Standard Dev. σ_j
DATA INPUTS FOR MODEL
DAILY NOISE DOSE
$d_i = \sum_j f_{ij}$
FRACTIONAL NOISE DOSE
$f_{ij} = C_{ij}/T_j$
OSHA EXPOSURE ASSESSMENT OUTPUTS
OSHA NOISE REGULATION
$T_j = \frac{8}{2^{(L_j - 90)/5}}$
WORST CASE DAILY NOISE DOSE
$d_i(w.c.) = \sum_j \bar{f}_{ij}$
WORST CASE FRACTIONAL NOISE DOSE
$\bar{f}_{ij} = \bar{C}_{ij}/\bar{T}_j$
NOISE EXPOSURE SUMMARY
$P_T = \sum_i P_i$
$P_i(d_i > 1.0)$ No. of Personnel Overexp.
$P_i[d_i(w.c.) > 1.0]$ Worst Case No. of Personnel Overexposed
OSHA NOISE REGULATION
$\bar{T}_j = \frac{8}{2^{(\bar{L}_j - 90)/5}}$
$L_{eq}(8)_{in} = \left[\frac{C_{ij}}{8} 10^{L_j/10}\right] e_{in}$
$LWP_{in} = \frac{10^{[L_{eq}(8)_{in}/10]}}{10^{[L_{eq}(8)_i/10]}} LWP_i$
WORST CASE INPUT DATA
$\bar{L}_j = L_j + \sigma_j$ (For highest L_j in category i)
$\bar{L}_j = L_j$ (For all other L_j)
$\hat{C}_{ij} = C_{ij} + \sigma_i\ (\bar{L}_j \neq L_j)$
$\hat{C}_{ij} = C_{ij}\ (\bar{L}_j = L_j)$
$\bar{C}_{ij} = 8\hat{C}_{ij}/\sum_j \hat{C}_{ij}$
8 HR EQUIVALENT NOISE LEVEL $L_{eq}(8)_i$
$L_{eq}(8)_i = 10 \log_{10} \sum_j \left(\frac{C_{ij}}{8}\right) 10^{(L_j/10)}$
WORST CASE EQUIVALENT NOISE LEVEL $L_{eq}(8)_i(w.c.)$
$[L_{eq}(8)(w.c.)]_i = 10 \log_{10} \sum_j \frac{\bar{C}_{ij}}{8} 10^{\bar{L}_j/10}$
SUBSCRIPT DEFINITIONS
k = subset of i where $d_k > 1.0$, k = 1, 2
n = subset of j where $f_{kn} = e_{nj} f_{kj}$
e_{nj} = contribution of equipment n to noise Level L_j
HEARING LOSS WEIGHTING FUNCTION
$(W_h)_i = 0.025\,[L_{eq}(8)_i - 75]^2$
HEARING LOSS WEIGHTING FUNCTION
$[W_h(w.c.)]_i = 0.025\,[L_{eq}(8)(w.c.)_i - 75]^2$
PARTIAL EQUIPMENT IMPACT
$PP_n = LWP_{in}/LWP_i$
PARTIAL PRIORITY
$PP_{kn} = f_{kn}/d_k$
PRIORITY INDEX (PI_n)
$PI_n = \sum_k \frac{P_k f_{kn}}{d_k}$
NORMALIZED PRIORITY INDEX
$NPI_n = PI_n/\sum_n PI_n$
EXPOSURE PRIORITY INDEX
$EPI_n = \sum_k P_k f_{kn}$
Normalized
$NEPI_n = EPI_n/\sum_n EPI_n$
OSHA EQUIPMENT IMPACT ASSESSMENT OUTPUTS
LEVEL WEIGHTED POPULATION
$LWP_i = P_i (W_h)_i$
WORST CASE LEVEL WEIGHTED POPULATION
$[LWP(w.c.)]_i = P_i\,[W_h(w.c.)]_i$
TOTAL LWP FOR PLANT OR INDUSTRY
$LWP = \sum_i LWP_i$
TOTAL W.C. LWP FOR PLANT OR INDUSTRY
$LWP(w.c.) = \sum_i [LWP(w.c.)]_i$
NOISE EXPOSURE SUMMARY
$P_T = \sum_i P_i$
$P_i(75)$ = No of Personnel with $L_{eq}(8) > 75$ dBA
$[P_i(75)](w.c.)$ = Worst Case No. of Personnel with $L_{eq}(8) > 75$ dBA
$P_i(90)$ = No. of Personnel with $L_{eq}(8) > 90$ dBA
$[P_i(90)](w.c.)$ = Worst Case No. of Personnel with $L_{eq}(8) > 90$ dBA
EPA EXPOSURE ASSESSMENT OUTPUTS
TOTAL EQUIPMENT IMPACT
$PI_n = \sum_i P_i\,LWP_{in}/LWP_i$
NORMALIZED EQUIPMENT IMPACT
$NPI_n = PI_n/\sum_n PI_n$
EQUIPMENT EXPOSURE PRIORITY
$EPI_n = \sum_i P_i\,LWP_{in}$
Normalized
$NEPI_n = EPI_n/\sum_n EPI_n$
EPA EQUIPMENT IMPACT ASSESSMENT OUTPUTS

The first requirement of the data base is the physical noise data. These data include noise level measurements at operator locations for each equipment item ("equipment noise data") and noise level measurements in selected areas removed from any specific equipment items ("background noise data"). The "background noise data" consist of noise levels which usually represent an area and are made up of contributions from one or more equipment types. The relative contributions of each category of equipment to the background level is assessed on a subjective basis by the person taking the measurements. The total relative contribution from all equipment categories must add up to unity. For example, if the contribution from a particular category of equipment is considered to be 10 dB down from the measured level, a relative contribution of 0.1 is recorded. Similarly, if the contribution of another category of equipment is considered to be 3 dB down from the measured level, then a relative contribution of 0.5 is recorded. Table 3-1 gives a more detailed breakdown.

The relative contribution data allow the background noise data to be used together with the equipment noise data for the assessment of the relative equipment impacts on overall personnel exposure.

In an attempt to keep the data acquisition as simple as possible, the maximum number of equipment types considered for any given location is limited to three. However, data for different locations having the same background I.D. code may include a different set of three equipment types. The total number of different equipment types allowed for any one background code is 20. If more are necessary a different background code should be used. Small errors in the subjective assessment of the relative contributions for each equipment category are acceptable as these data have a second order effect on the overall results.

Table 3-1 Relative Contributions of Equipment Categories to the Overall Noise Level Measured at a Given Location

Number of dB by which the equipment contribution is considered to be below the measured level at the particular location (Subjective assessment)	Relative Contribution e to overall measured noise level, L_j (Model input data) e_{jn}
10	0.1
9	0.1
8	0.2
7	0.2
6	0.2
5	0.3
4	0.4
3	0.5
2	0.6
1	0.8
0.5	0.9

Note: The total relative contribution at any one location from all contributing equipment types must add up to unity.

The size of the area associated with each background measurement will depend on the fluctuations of noise level in the area and the accuracy required. Note that if several items of equipment of the same type contribute to the noise level at a particular location, they should be lumped together and only their total relative contribution at that location should be recorded. Each background location is described in the model and identified with the equipment category which contributes most to the measured level. If the background level is 75 dBA or less, equipment contributors need not be identified. A contribution of 1.0 should be assigned to code 1000 which indicates a background less than 75 dBA. When detailed equipment categories are combined into generalized classifications, background levels are excluded unless no other equipment data exist.

The second requirement of the data base is the description and classification of personnel categories and the description of job assignments for each category. For a given category, each assignment corresponds to a particular percentage of the working day in a particular location where the noise levels have been defined, the total assignment to add up to 100%.

Personnel category descriptions consist of names which are in common use in the industry under consideration. Ideally, each category should contain personnel with similar job assignments. In practice this is not always possible due to variability in job assignments on both a personnel and daily basis.

The variability in equipment type or location assignment for personnel in a given category appearing in the input data is taken into account in the computer model by dividing the category into separate subcategories. Within each subcategory a variation between data sets, in the time allocated to each job assignment, is allowed, but a variability in the type of job assignments is not allowed. The input job assignment data should represent an annual average and the accuracy of each set of data will depend on the ability to predict average personnel movements over the plant in the long term. Thus, each input data set contains the category description, a list of job assignments, the corresponding percentage of time allocated to each assignment and the number of people this applies to on an annual basis. There may be several data sets for a given personnel category in any one plant. Each data set may contain differing assignment times and differing assignments types.

In addition to the four types of data mentioned above the computer program requires user oriented input data which determines the type of analysis (OSHA or EPA) to be done and the depth of the analysis (one or several plants or extrapolation to an entire industry). For the extrapolation to the entire industry data concerning the total population of the industry are required. These user oriented data input requirements are discussed more fully in Appendix B of this report.

3.2 Data Inputs for Noise Exposure Models

The selection from the data base of data which are to be used for an analysis is determined by the content of the user oriented data which is discussed in detail in Appendix B. Data may be selected for a given plant or all the above data for an entire industry may be selected.

Selected work assignment data sets which contain the same work assignments and belong to the same personnel category are combined together, and for each different work assignment a mean C_{ij} and standard deviation σ_i is calculated for the times spent on each assignment. For the calculation, the data sets are weighted by the number of personnel involved. If data sets for the same personnel category contain different work assignments then the category is split into sub categories by the computer program.

Selected equipment and background noise data are also grouped by I.D. code and for each different I.D. code a mean L_j and standard deviation σ_j is calculated for the measured noise levels.

A list of equipment codes to be grouped into general equipment classifications is included in the user oriented data input. All data for a general classification are combined to give a mean and standard deviation for the noise level corresponding to each classification. These data are then referred to as "generalized equipment data". No background noise data are included in the generalized equipment data. Details for selection of generalized classifications are discussed in

Appendix B, and examples are given in Section 5 for both the Sawmill and Foundry industries.

When an entire industry analysis is requested by the user oriented data the available data from plants within the industry are used together with the total industry population to obtain the required results. The accuracy of these resuls is determined by the number of plants included in the available data. Clearly the accuracy would be best if data from every plant in the industry were available and equally clearly this would be impractical. The alternative is to use the data from a random selection of plants within the industry to estimate the exposure problem for the entire industry, and to use the variability in the data to estimate a worst case situation.

The worst case estimate is derived from the standard deviation estimates $_i$ and $_j$ for the quantities C_{ij} and L_j.
The accuracy of the estimates for the mean exposure problem and the worst case exposure problem increases as the number of plants increases. This is discussed in detail in Section 6 of this report. The worst case estimates are not valid and should be ignored when a single plant is chosen for analysis and no extrapolation of results is required.

3.3 Development of the Noise Exposure Models

Two models are developed and results are compared later in this report. The first model uses the EPA criterion as a basis and the second uses the OSHA criterion as the basis.

3.3.1 EPA Model

The impact of a particular noise environment on an individual or personnel category is a function of both the sound level and the size of the population experiencing that sound level. EPA has established a method which can be used to assess the noise impact of a given environment through the calculation of fractional impacts from each contributor to the overall environment. For occupational noise exposure EPA has adopted the eight-hour equivalent sound level $L_{eq}(8)$ to quantify the noise levels to which personnel are exposed. For a given personnel category, i, the equivalent 8-hour sound level may be calculated by summing the contributions of each job assignment as follows:

$$L_{eq}(8)_i = 10 \log_{10} \sum_{j=1}^{N} \frac{C_{ij}}{8} 10^{(L_j/10)} \qquad (3\text{-}1)$$

There are N job assignments, the j^{th} job assignment corresponding to an average sound level of L_j dBA and an exposure time of C_{ij} hours.

In the "Levels Document" [1], EPA identifies an $L_{eq}(8)$ of 75 dBA as the criterion to protect against hearing loss and various gradations of impact for levels exceeding these limits. The impact of a value of $L_{eq}(8)_i$ on a particular population i may be quantified by a single number which takes into account the value of $L_{eq}(8)_i$ and the number of personnel exposed.

This number is referred to as Level Weighted Population (LWP_i) and allows differing numerical degrees of impact to be applied to different segments of the population. The formulation of LWP relies on the use of a weighting function W_h to link the importance of sound level magnitude to the importance of population magnitude in assessing overall impact.

The weighting function W_h is calculated from the eight hour equivalent sound level for a particular population or personnel category i using the following relation:

$$(W_h)_i = 0.025\ (L_{eq}(8)_i - 75)^2 \qquad (3\text{-}2)$$

If $L_{eq}(8)_i$ is less than 75 dBA then $(W_h)_i = 0$.

The level weighted population for this i^{th} category is then defined as,

$$LWP_i = (W_h)_i \cdot P_i, \qquad (3\text{-}3)$$

where P_i is the population in personnel category i.

The Level Weighted Population for an entire industry is obtained by summing over all personnel categories i. Thus,

$$LWP = \sum_i LWP_i \qquad (3\text{-}4)$$

The use of the LWP descriptor for noise impact implies the following:

1. The impact of high noise levels on a small number of people is equivalent to the impact of lower noise levels on a larger number of people. This equivalence is expressed in the equation for the weighting function W_h and the equation for LWP.

2. The properties of sound intensity and number of people affected by it may be mathematically combined into a single descriptor, LWP.

The quantity LWP_i defined for each personnel category i may be used to rank order personnel categories in terms of noise exposure impact, and hence the impact of various personnel classifications on hearing loss within an industry.

Worst case exposure estimates are calculated from the mean and standard deviation values of the C_{ij} and L_j used in Equation 3-1. The worst case estimate for $L_{eq}(8)_i$ is given by

$$\left[L_{eq}(8)(w.c.)\right]_i = 10 \log_{10} \sum_{j=1}^{N} \frac{\bar{C}_{ij}}{8} 10^{(\bar{L}_j/10)} \qquad (3\text{-}5)$$

where $\bar{L}_j = L_j + \sigma_j$ (for highest L_j assigned to category i)
$\bar{L}_j = L_j$ (for all other L_j)
$\hat{C}_{ij} = C_{ij} + \sigma_i \ (\bar{L}_j \neq L_j)$
$\hat{C}_{ij} = C_{ij} \ (\bar{L}_j = L_j)$
$\bar{C}_{ij} = 8\ C_{ij} / \sum_i \hat{C}_{ij}$

The worst case LWP values are calculated in a similar way as the mean values, except $L_{eq}(8)_i$ is replaced by $L_{eq}(8)_i(w.c.)$ in expression (3-2).

The accuracy of the estimates of the mean and worst case for the exposure is improved each time more data are added to the data base. Generally at least four plants are required in the sample for estimates of the worst case exposure to be reasonably accurate. If fewer plants are used there are usually not enough data to obtain accurate estimates of the standard deviations in the quantities used for the worst case estimates. In addition to industry-wide estimates, the model is suitable for analysis of individual plants. In this instance the worst case estimates should be ignored.

Note that each noise level is associated with a particular type of equipment or background which itself may be made up of contributions from several equipment types.

3.3.2 OSHA Model

OSHA regulations permit a maximum allowable noise level of 90 dBA for 8 hours, or a daily noise dose of unity. For exposure to N different noise environments the daily noise dose d_i corresponding to personnel classification i is defined as follows:

$$d_i = \frac{C_{i1}}{T_1} \quad \frac{C_{i2}}{T_2} \quad \ldots + \frac{C_{iN}}{T_N} = \sum_{j=1}^{N} f_{ij} \qquad (3-6)$$

where C_{ij} is the exposure time of personnel category i to noise level L_j.

T_j is the total time of exposure permitted at level L_j and is defined as,

$$T_j = \frac{8}{2^{(L_j - 90)/5}} = 8 \text{ hours for } L_j = 90 \text{ dBA} \qquad (3-7)$$

When the daily noise dose exceeds unity the personnel noise exposure is above the permissible level.

The equivalent eight hour sound level $L_{eq}(8)_i$ experienced by personnel category i may be derived from the daily noise dose as follows:

$$L_{eq}(8)_i = 90 + 5 \log_2 d_i = 90 + 5 \left[3.322 \log_{10} d_i\right] \qquad (3-8)$$

The above computation methods identify the following important factors.

1. Noise levels above 90 dBA are potential hearing hazards. 90 dBA is the maximum allowable exposure for the 8-hour work day and also represents the threshold of noise. That is, noise levels below 90 dBA are not considered.

2. The exchange rate between level and time of exposure is 5 dBA. That is, for each halving of exposure time, the allowable noise level may be increased by 5 dBA (i.e., 95 dBA for 4 hrs.; 100 dBA for 2 hrs., etc.).

3. When multiple exposures to different noise levels exist during the work day, the Daily Noise Dose is computed by adding fractional exposures.

4. The degree of overexposure is indicated by the magnitude of the daily noise dose and in contrast to the EPA model, no consideration is given to the number of people involved in each category i. Thus a category with one person exposed to a high noise level (e.g. 110 dBA) is seen as being more important than a category with 100 people exposed to a lower noise level (e.g. 105 dBA).

The results for the noise exposure impact of an entire industry are quantified by adding together the total number of people with a daily noise dose in excess of one.

The worst case daily noise dose $d_i(\text{w.c.})$ is calculated by replacing the quantities C_{ij} and L_j with the quantities $\bar{C}_{ij}$ and $\bar{L}_j$, (which are the same as those used in Eq.(3-5)) in Eqs.(3-6) and (3-7). The worst case eight hour equivalent sound level $\left[L_{eq}(8)(\text{w.c.})\right]_i$ is calculated from $d_i(\text{w.c.})$ using Eq.(3-8).

3.4 Development of Models for Assessing the Relative Impact of Equipment Types on Personnel Noise Exposure

As for the previous section two models are developed; one based on EPA criteria and the second based on OSHA criteria.

3.4.1 EPA Model

In Section 3.3.1 we showed how personnel categories could be rank ordered in terms of their noise exposure impact. The purpose of this section is to derive expressions to allow a similar rank ordering of equipment types.

We begin with Equation (3-1) which shows how the equivalent eight hour noise level may be calculated for a given personnel category i exposed to several different noise environments j. The contribution of noise environment j to the value of $L_{eq}(8)_i$ is defined as $L_{eq}(8)_{ij}$ and is given as:

$$L_{eq}(8)_{ij} = 10 \log_{10} \left[\left(\frac{C_{ij}}{8} \right) 10^{L_j/10} \right] \tag{3-9}$$

The noise environment L_j may be associated directly with a single equipment type or may correspond to a background noise level characterized by several different equipment types. Thus the contribution of equipment type n to the value of $L_{eq}(8)_i$ is given by

$$L_{eq}(8)_{in} = 10 \log_{10} \left[\left(\frac{C_{ij}}{8} 10^{L_j/10} \right) e_{jn} \right] \tag{3-10}$$

where e_{jn} is the contribution of equipment type n to the noise environment L_j (see Table 3-1). e_{jn} has a value of 1 for equipment noise data and a value between 0 and 1 for background noise data.

The contribution of equipment type n to the overall LWP for personnel category i may be written as,

$$LWP_{in} = \frac{10^{[L_{eq}(8)_{in}/10]}}{10^{[L_{eq}(8)_{i}/10]}} LWP_i \qquad (3\text{-}11)$$

The relative impact of equipment type n on the total noise impact experienced by personnel category i may be expressed as a partial priority as follows:

$$(PP)_{in} = LWP_{in}/LWP_i \qquad (3\text{-}12)$$

The relative impact of one equipment class n on the exposure problem for all personnel categories in a given industry is then defined as:

$$PI_n = \sum_i \frac{P_i LWP_{in}}{LWP_i} = \sum_i P_i \frac{10^{[L_{eq}(8)_{in}/10]}}{10^{[L_{eq}(8)_{i}/10]}} \qquad (3\text{-}13)$$

where PI_n is the equipment impact for equipment type n.

The equipment impact may be normalized to unity as follows:

$$NPI_n = PI_n / \sum_n PI_n \qquad (3\text{-}14)$$

The PI_n result allows the rank ordering of equipment types in terms of their impact on the exposure problem. The exposure problem is defined as the existence of personnel exposed to an $L_{eq}(8)$ in excess of 75 dBA. The degree of overexposure or the amount by which $L_{eq}(8)$ exceeds 75 dBA is not taken into account.

The rank ordering of equipment types in terms of the impact on overall exposure is also desirable and may be expressed in terms of a new index which we will refer to as the Equipment Exposure Impact which is defined as follows:

$$EPI = \sum_{i} LWP \qquad (3\text{-}15)$$

and which may be normalized in a similar way to the equipment impact (Eq.3-14).
This rank ordering indicates which equipment types contribute most to overexposure and is available as an output from the computer program. The statistical analysis in Section 6 and the results presented in Section 5 however are based on Eq.(3-14).

If a broader assessment basis is desired such as the identification of important areas rather than important equipment types in a plant or industry, then the same model can be used with equipment noise levels being replaced with area noise levels and personnel assignments reflecting plant areas rather than equipment usage. In this case it would not be necessary to identify equipment types contributing to background noise levels.

3.4.2 OSHA Model

The purpose of this section is to derive expressions which allow rank ordering of the impact of various equipment types on personnel exposure, using OSHA criteria as a basis.

To begin with, the impact of equipment is considered only for those personnel categories with a daily noise dose in excess of one. Thus we only consider categories k where k is a subset of the original category list and k = 1, .

Thus Equation (3-6) may be rewritten as

$$d_k = \sum_{k=1}^{\ell} f_{kj} \qquad (3\text{-}16)$$

where k is a subset of i, ℓ is the total number of personnel categories with a daily noise dose in excess of unity, and where

$$f_{kj} = C_{kj}/T_j \qquad (3\text{-}17)$$

As for the EPA model the noise environment L_j may be associated with one or more equipment types n. Thus the contribution of equipment type n to the daily noise dose d_k is given by

$$f_{kn} = e_{nj} f_{kj} \qquad (3\text{-}18)$$

e_{nj} = 1 for equipment noise data and is between 0 and 1 for background noise data.

The relative impact of equipment class n on the total noise impact experienced by personnel category i is written as a partial priority as follows

$$(PP)_{kn} = f_{kn}/d_k \qquad (3\text{-}19)$$

The relative impact of one equipment class n on the exposure problem for all personnel categories in a given industry is defined as:

$$PI_n = \sum_{k=1}^{\ell} \frac{P_k f_{kn}}{d_k} \qquad (3\text{-}20)$$

where P_k is the number of people in personnel category k and where PI_n is the priority index for equipment type n. Note that the number of personnel overexposed in each category is taken into account in this calculation.

The priority index may be normalized to unity as follows:

$$NPI_n = PI_n \Big/ \sum PI_n \qquad (3\text{-}21)$$

This PI_n result allows the rank ordering of equipment types in terms of their impact on the exposure problem. The exposure problem is defined as the existence of personnel with a daily noise dose in excess of unity. The amount by which the daily noise dose exceeds unity is not taken into account, although the number of personnel involved is taken into account.

The rank ordering of equipment types in terms of the impact on overall exposure, and where the amount by which the daily noise dose exceeds unity and the number of personnel involved are both taken into account, is also desirable. In this case the priority is referred to as the exposure priority index, and is defined as:

$$EPI_n = \sum_{k=1}^{\ell} P_k f_{kn} \qquad (3\text{-}22)$$

This rank ordering indicates which equipment types contribute most to overexposure and is available as an output from the computer program. The exposure priority index may also be normalized in the same way as for the priority index.

3.5 Computer Model

The computer model evaluates the equations described previously for each personnel category and for each equipment type specified in the input data. The overall results for each individual plant are obtained and then averaged and extrapolated to the entire industry. The results for the Sawmill Industry (SIC 242) and the Foundry Industry (SIC 332) are presented in Section 5 of this report. The output data of interest for the personnel categories are the "Level Weighted Population" (Equation 3-3) and the "Daily Noise Dose" (Equation 3-6) for each personnel category. Each personnel category is listed in the computer output in order of importance, in terms of noise exposure impact. In addition, results for the total level weighted population and total number of people overexposed in each industry considered are presented.

The output data of interest for the equipment types are the priority indices calculated using both EPA (Equation 3-13) and OSHA (Equation 3-20) criteria. Equipment types are listed in the computer output in order of their importance in contributing to the noise exposure problem.

In addition, the computer model at this stage is capable of taking into account the effect of noise control in any specified equipment types as described in Appendix A. This allows the effect of any proposed noise control legislation to be immediately evaluated. Results for an arbitrary example are included in Section 5. The computer model automatically reduces by the correct magnitude, background noise levels which are influenced by equipment types for which noise control is specified. After noise reduction, the relative contributions of equipment types to the background level under consideration are recalculated, prior to the calculation of the equipment priority indices.

The accuracy of the results obtained by extrapolating average results for several plants to an entire industry is discussed in Section 6.

Proposed additions to the computer model capabilities are discussed in detail in Appendix B, Section B.3 and in general terms in Section 7 of this report.

Section 4
FIELD DATA ACQUISITION PROGRAM

Section 3.1 discussed in detail the data base requirements needed to describe the personnel noise exposure problem. Both the acoustic and non-acoustic parameters to be measured were identified in general and their relationships to the models were shown in subsequent sections. This section of the report deals with the specific procedures used during the data acquisition program. The objective is to provide the user with the required methodology to repeat these measurements in other plants and industries.

4.1 Industries Selected

Two industries were selected for detailed analysis under this program. These are:

1.	SIC 242	Sawmills and Planing Mills
2.	SIC 332	Iron and Steel Foundries

The selection of these industries was based in part on the familiarity of the contractor with their operations and in part on the willingness of these industries to voluntarily participate in this study.

After consultation with representatives from each industry, a number of "typical" plants were selected for detailed examination. The criteria for the plant selection were as follows:

1. Obtain a representative group in terms of plant size (number of people employed and production levels);

2. Include plants that would span the industry age; i.e. modern plants with new equipment and processes and older plants,

3. Include plants that would contain a representative sample of equipment used in the industry.

The objective of this selection process was to obtain the broadest sample of equipment and operational procedures possible, to ensure that the industry is adequately described. Since the project was limited in the number of plants in each industry which could be surveyed, this procedure for plant selection was intended to not only provide a representative sample but also to ascertain the minimum sample size necessary in each industry for a desired level of accuracy (see Section 6 for further discussion of this subject).

Four plants in each industry were selected originally through this method. Five additional plants in SIC 242 and four in SIC 332 were later added in lieu of surveys in other industries. All volunteer plants are anonymous by agreement between EPA and industry representatives. Thus, each plant is described only by a number.

4.2 Field Data Acquisition

All plants in each industry were visited sequentially by the same survey team. An average of 8 - 16 hours is required for a trained individual to complete a plant. The methodology used in both industries was the same. As an illustration of the procedures the sawmill and planing mill industry will be used; however the steps to be followed are similar in other industry environments.

Two basic types of data are required in order to fulfill the requirements of the model as described in Section 3.1. They are:

1. Airborne Noise Data
2. Personnel Work Assignment Data

Although these data are not mutually exclusive (some must be collected together), the procedures for the two data types are discussed separately for clarity. When appropriate, notes concerning the relationship between these data types are included.

4.2.1 Airborne Noise Data

The airborne noise data refers to the acoustic (noise) measurements that are necessary to describe the environment in each plant situation. The units of measurement are the "A-weighted" sound level (dBA) which are familiar to most individuals working in occupational noise. Both the EPA and OSHA critera (see Section 2) use the "A-weighted" sound level as the basic descriptor of noise.

Instrumentation

The instrumentation required for the survey is a Type II Sound Level Meter or better. Noise measurements are taken with the instrument setting on the "A" scale and slow averaging.

Data Forms

Although not essential, it was found useful to develop and use standard forms for recording the measured noise data. The forms suggested here are designed to allow direct conversion into punch cards compatible with the computer program. This avoids the need to transfer field data into the format required for key punching.

The acquisition of the noise level data requires two types of forms. These are:

1. List of Equipment
2. Equipment Noise Data

An example of the "List of Equipment" form is shown in Figure 4-1. This list allows for the orderly assignment and retrieval of equipment code numbers used in the model.

Basically, each equipment type in an industry is assigned a four digit numerical code as shown in Figure 4-1. This code is unique to the equipment or background type and is independent of the industry being surveyed. Thus, survey personnel need to know which codes have been used previously. The gross description of the equipment item is provided by its Generic Name (see column two). Thus Code 1610 describes a cut-off saw in general. If no further breakdown was desired, then Code 1610 would be sufficient to describe all cut-off saws used in the industry.

Due to variations in general configuration, method of operation or operator location it is desirable to further break down some equipment items into sub-categories. In our example for cut-off saws a distinction is made in column three between circular and chain types (change in configuration). This same reasoning is used for edgers to differentiate "manual" types from "automatic" types (method of operation). Finally, the headrig illustrates the breakdown based on operator location by identifying a "sawyer location" and a "tail operator location". The criteria for establishing when a type breakdown is necessary is basically the noise level emission.

A further breakdown is occasionally desirable due to a significant change in the noise emission level between different equipment items of the same type. This breakdown is shown in the fourth column under the heading size/condition. The two most important conditions are the distinction between the equipment operating under either "idle" or "operating" mode

FIGURE 4.1 EXAMPLE OF ENTRIES INTO "LIST OF EQUIPMENT" FORM

LIST OF EQUIPMENT	NAME
SIC CODE: 242	DATE 3/4/79 PAGE OF

4 Dig. Euip. Code	Generic Name	Type (Auto., Man., Etc.)	Size / Condition	
1610	CUT-OFF SAW	GENERAL	GENERAL	
1611	BACK/CUT OFF SAW	CUT-OFF SAW		
1612	CUT-OFF SAW	CIRCULAR	IDLE/ENCLOSED	
1613	CUT-OFF SAW	CIRCULAR	OPERATING/ENCL	
1614	CUT-OFF SAW	CIRCULAR	IDLE	
1615	CUT-OFF SAW	CIRCULAR	OPERATING	
1616	CUT-OFF SAW	CHAIN	IDLE/ENCLOSED	
⋮				
⋮				
1624	HEADRIG	BANDSAW/SAWYER		
1625	HEADRIG			
1626	HEADRIG	BANDSAW/TAIL		

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and the distinction between the equipment being "enclosed" or not. For example Code 1613 (see Figure 4-1) describes a circular cut-off saw which has an acoustical enclosure and was measured under operating conditions (while cutting).

When an industry has been surveyed previously, the "List of Equipment" will already have been generated. In this case, the survey team would only use the existing information to identify the correct code number. In the case of a new industry, enough familiarity with the industry process is required so as to establish the necessary categories. As will be shown later, the model has the ability to analyze the input information based on the detailed equipment type breakdown or to combine selected equipment types with the same generic name into broad classifications in order to analyze general equipment trends. Note that equipment types with the same generic name and likely to be included in the same general classification should be assigned consecutive I.D. codes.

Note that each equipment type has an entry where the generic name is preceeded by the letters "Back". This code represents a "Background Noise Level" which is primarily generated by the equipment in question. While all the other codes apply only at a location where the equipment operator is positioned, the background code identifies any other location usually removed from the equipment where the equipment operation has either a total or partial effect on the noise environment measured. Background noise levels are generally influenced by more than one type of equipment and the definition and measurement of the required data are discussed in detail later in this section.

The second noise level data form is shown in Figure 4-2. This form is used to record the noise level measurements performed during the survey. Figure 4-2 shows an example where the noise level at several locations is measured. Note that it is

FIGURE 4.2 EXAMPLE OF ENTRIES INTO "EQUIPMENT NOISE DATA" FORM

EQUIPMENT NOISE DATA	NAME
SIC CODE : 242	DATE 3/4/79 · PAGE OF

	4 Dig. Equip. Code	Equipment or Background Description		L_{eq} (dBA)		Contributions from Major Items of Equipment						
						Code	Contr.	Code	Contr.	Code	Contr.	
	1613	CUT-OFF/CIR/OPER		99.0								
	1613	CUT-OFF/CIR/OPER		101.0								
	1612	CUT-OFF/CIR/IDLE		84.0								
	1636	EDGER/MAN/OPER		99.0								
	1636	EDGER/MAN/OPER		97.0								
	1635	EDGER/MAN/IDLE		92.0								
	1627	HEADR/TAIL/OPER		111.0								
	1626	HEADR/TAIL/IDLE		94.0								
	1624	HEADR/SAWY/IDLE		82.0								
	1625	HEADR/SAWY/OPER		85.0								
	1621	BACK/HEADRIG		85.0		1625	0.80	1624	0.20			
	1630	BACK/EDGER		92.0		1636	0.60	1623	0.20	1613	0.20	

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sufficient to identify each measurement by the equipment code only. The generic description is included on the form for convenience only since the program requires the code as the only identification. The entries for equipment noise identify the code which represents the operator location for the equipment under consideration. Noise levels are measured at this location. The entries for background noise identify the code which represents the main equipment source that contributes to the measured level. A further breakdown of the background level in terms of the contributions from different equipment types as shown in Figure 4-2 are also included. The procedure for contribution assignments for background noise data is discussed in detail under Noise Measurements.

Equivalent Sound Level (L_{eq})

By definition, the Equivalent Sound Level (L_{eq}) is the steady dBA level which would produce the same A-weighted sound energy over a stated period of time as a specified time-varying sound.

When taking measurements of a machine operating under a specific set of conditions it is assumed that the sound does not vary significantly as a function of time, i.e., less than ±2.0 dBA. The assignment of separate codes to the cut-off saw used in our previous example (see Figure 4-1) recognizes the fact that this source generated different noise levels when idling or cutting.

When operating under a steady set of conditions therefore, our measurements will reflect closely the L_{eq} level desired. In practice, most noise sources are not perfectly steady and vary as a function of time. Some eye averaging must be done to approximate the L_{eq} value. This is accomplished by observing the Sound Level Meter display with the "slow" response selected for a time sufficient to establish an average value.

Noise Measurements

This section provides general guidelines to be followed during the noise measurement survey. The steps provided should allow the survey team to proceed quickly and efficiently through the data acquisition process. The following of these guidelines will also assure a standardized method for data collection.

1. Familiarization with the plant process and layout by conducting a walk-through prior to commencing measurements.

2. If the plant is one continuous process the survey should start at the beginning and follow the process from station-to-station. If not, each area of the plant should be completed before moving to the next one.

3. All noise measurements should be taken at the operator position, except background noise. Measurements should be made at ear height or equivalent.

4. Using the "List of Equipment" form the four-digit code for the equipment to be surveyed should be entered on the "Equipment Noise Data" form.

5. The L_{eq} (dBA) value for each condition identified (i.e., idle, operating) should then be measured and noted on the "Equipment Noise Data" form. Measurements should be taken over a period sufficient to establish an average value.

6. The above procedure should be repeated for the remaining equipment items until all fixed employee locations have been surveyed.

7. Background noise levels are determined by measuring an "average noise level" which can describe an area or a space in the plant. To establish the size of the area which can be described by a single noise level the following procedure should be used:

   (a) The noise environment away from any major equipment noise sources should be sampled with a sound level meter. Walkways, work benches and other employee locations are areas of special interest. As the sample survey is made the variation in sound level from location to location should be noted.

   (b) If the sound level at all locations is relatively steady (±3.0 dBA) then the entire room or area can be described by a single sound level measurement, providing that item (e) is also true.

   (c) If the sound level in the room or space varies in excess of the criterion (±3.0 dBA) then the space should be sub-divided into two, four, etc. sub-spaces until the above criterion is met.

   (d) In each background space or sub-space the sound level (dBA) should be measured and entered on the "Equipment Noise Data" form. The equipment item which is the most important contributor to the level just measured is determined by observation and hearing (subjective assessment). The "List of Equipment" form is then referred to and the "Background Equipment Code" which corresponds to the equipment selected is identified and entered on the "Equipment Noise Data" form to identify the noise level measured.

Note: The background noise at any location is the combination of direct and reverberant sound generated by one or more sources of noise. The effect of each source at a given position can be determined by turning all equipment of and then measuring the contribution of each one individually. This, although desirable, is seldom, if ever, practical or possible. Therefore, procedures suggested here rely on a subjective judgment which must be made by the individual performing the survey. This subjective judgment will be used to not only establish which equipment item is the most important contributor to background noise but also to select in some cases two more sources which are important and to assign to each a relative value for their contribution to the measured noise. The selection of the correct relative value is discussed in detail in Section 3.1 of this report. Although, on the surface, this procedure appears very complicated and subject to large error, experience under real plant situations shows that accurate and consistent results are achieved after some initial training.

(e) The "Equipment Noise Data" form has three sets of entries called "Equipment Contribution to Background" following the column used to enter the L_{eq} measured value. These entries are to be used only for background noise measurements and are used as follows:

(1) Identify one, two or three equipment sources which contribute to the background noise at the measurement location. An easy rule of thumb is to list the equipment items which can be "heard" in order of importance. The ear

be "heard" in order of importance. The ear may be used as a filter to make this determination.

(ii) List the "Background Equipment Codes" for each source identified on the "Equipment Noise Data" (see "List of Equipment" for correct Codes). The Generic Name description of the background is always the most important equipment contributor (i.e. 1630 BACK/EDGER (see Figure 4-1)).

(iii) If only one major equipment source is identified since it completely dominates the background, then the relative contribution should be 1.0 dB. That is, when the equipment is reduced by 1.0 dBA, the background noise will also be reduced by the same amount.

(iv) If all three equipment items appear to be equally important, then the relative contributions to background noise should also be the same. Since the total must add to unity, then as a practical matter 0.4 is given to the equipment item whose generic name is used to describe the background noise and the remaining sources are assigned each 0.3 (see Figure 4-2). Note that in the case of only two sources, the relative contribution assignment would be 0.5.

(v) All other cases fall in between the two identified above. That is, the primary source of background noise cannot be larger than 1.0 or smaller than 0.4. If the primary source is judged to be twice as important as the remaining two then the relative contributions would be 0.6, 0.2 and 0.2 and so on.

Note: As was explained in Section 3.1 the objective of the background noise contribution assignment is to calculate the equipment noise exposure impacts more accurately and to allow for reductions in background noise when the equipment which controls their level is controlled.

4.2.2 Personnel Work Assignment

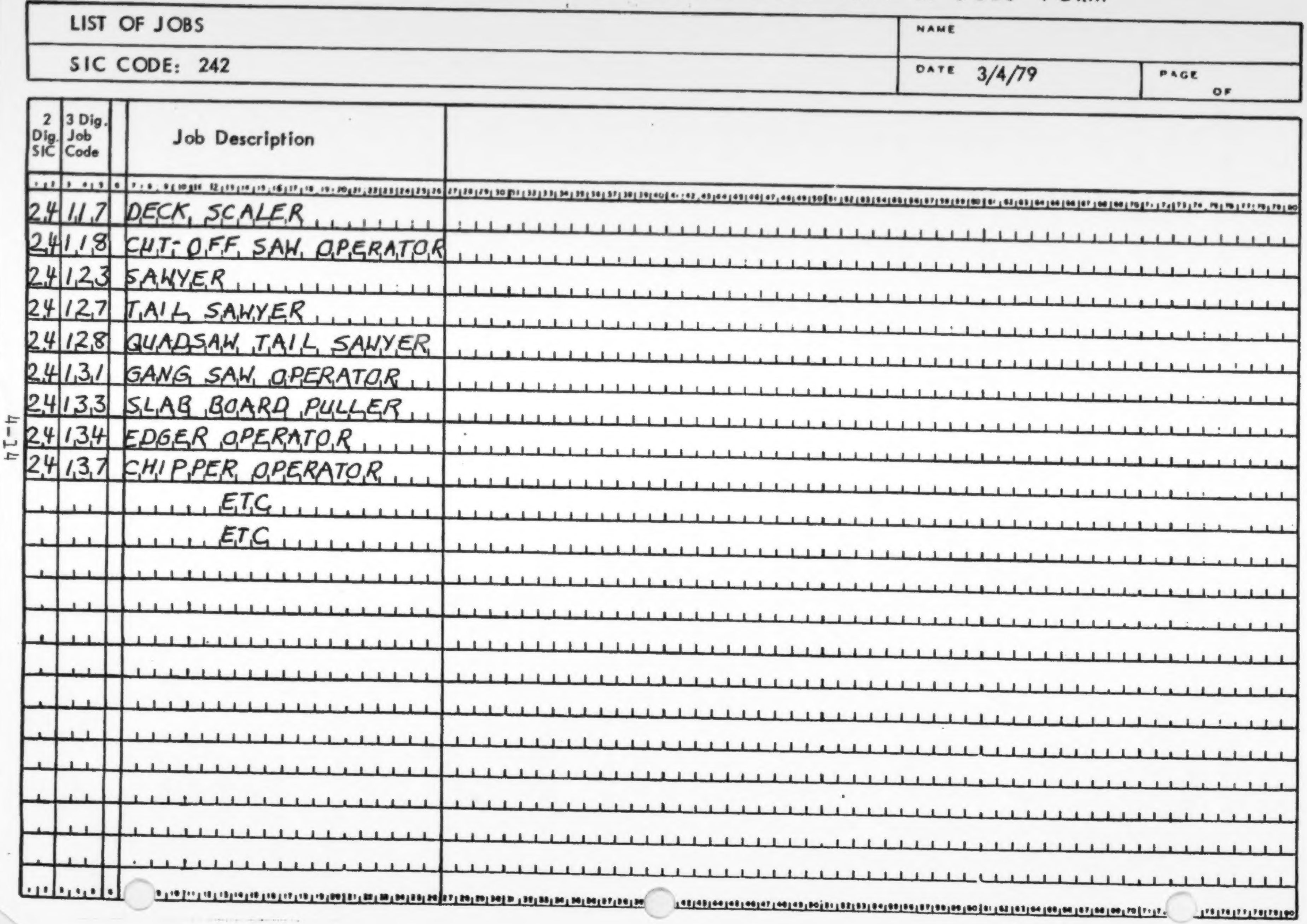
The personnel noise assignment is the second type of data necessary to exercise the computer model. In the previous section we have discussed the methodology necessary to collect the noise level information. This section describes the procedures used to relate worker exposure to those levels.

Employee Classification

The first step is to break down the employee force working in the plant into categories consistent with their work assignments and the manner in which they are described in the industry.

Both of these requirements are satisfied by identifying "Job Descriptions" which are common to the industry being surveyed. As was the case with the "List of Equipment", a "List of Jobs" is developed for each industry. A five-digit job code is assigned to each job description as shown in the example for the sawmill and planer mill industry on Figure 4-3. The first two digits are the first two digits of the SIC code for the industry and the last three digits are assigned arbitrarily for a given industry. Since "job descriptions" vary sometimes from plant to

FIGURE 4.3 EXAMPLE OF ENTRIES INTO "LIST OF JOBS" FORM



LIST OF JOBS	NAME
SIC CODE: 242	DATE 3/4/79	PAGE OF

2 Dig. SIC	3 Dig. Job Code		Job Description	
24	117		DECK SCALER	
24	118		CUT-OFF SAW OPERATOR	
24	123		SAWYER	
24	127		TAIL SAWYER	
24	128		QUADSAW TAIL SAWYER	
24	131		GANG SAW OPERATOR	
24	133		SLAB BOARD PULLER	
24	134		EDGER OPERATOR	
24	137		CHIPPER OPERATOR	
			ETC	
			ETC	

plant it is desirable to develop a reference list with the help of the industry or several plants to have a consistent methodology.

Units of Measurement

The final personnel work assignment description desired is in terms of the time expended operating a given item of equipment or exposed to a given background noise level. The units used to describe the time period are percentages of the working day where 8 hours = 100%. Numbers of hours (to one decimal place accuracy) are equally acceptable in place of percentages.

Data Forms

In addition to the "List of Jobs" previously described, the procedure utilizes the "Personnel Work Assignment" form. This form is shown on Figure 4-4. The form first identifies the Job Code which is the last three digits of the code described in the List of Jobs. Thus each job category has a unique number code by which it is designated. The number of personnel assigned to a specific job category are followed by the description of their duties and the number of hours of their working day assigned to various equipment and background noise sources. The equipment and background noise sources are identified by their four-digit codes as described earlier.

Personnel Work Assignments

This section provides the general guidelines to be followed during the survey to acquire the personnel work assignment data.

The same procedure can be applied by either: a) sampling each individual worker to establish his/her daily duties or b) arriving at average work assignment values for various job descrip-

FIGURE 4.4 EXAMPLE OF ENTRIES INTO "PERSONNEL WORK ASSIGNMENT" FORM

PERSONNEL WORK ASSIGNMENTS (2 LINES FOR EACH PERSONNEL CATEGORY)

NAME

SIC CODE: 242

PLANT NO. 02

DATE 3/4/79

PAGE OF

3 Dig. Pers. Code	Brief Description of Work for Own Benefit	No. of Pers.	Equip. Code	% Time	Equip. Code	% Time	Equip. Code	% Time	Equip. Code	% Time	Equip. Code	% Time	
134	EDGER OPERATOR	4	1635	50.0	1636	50.0							
			0										
127	TAIL SAWYER	2	1626	20.0	1627	80.0							
			0										
123	SAWYER	2	1624	20.0	1625	80.0							
			0										
117	DECK SCALER	2	1613	5.0	1621	95.0							
			0										
101	SAWMILL SUPERVIS	1	1798	50.0	1776	120.0	1621	15.0	1630	15.0			
			0										
300	CARPENTER	2	1000	50.0	1776	15.0	1621	15.0	1630	10.0	1700	10.0	
			0										

tions by discussing work assignments with the first line supervisors. In large plants, the later method is more practical. By experience, the following method gives the most consistent results:

1. For each department or area the total number of employees is first acquired (sometimes more than one shift may have to be considered).

2. With the help of the List of Jobs, the job descriptions and job codes present are then identified and entered on the Personnel Work Assignment form. As was pointed out earlier, the job designation from plant to plant may vary; however in most cases, the supervisor of the area will be able to identify the corresponding job title from the List of Jobs.

3. If it is decided to work with the supervisor, the number of workers in each job category and their duties should be identified first of all and entered on the Personnel Work Assignment form. The next task would be the correct definition of the daily job assignments for the plant's workforce. This is the most difficult part of the survey since in many industries, the tasks performed by an individual may vary from day-to-day. The degree of variability may be reduced by remembering that the aim of the data is to describe the long term problem rather than the individual day of the survey. Thus, questions such as a) what are the duties of this worker or group of workers on the average (over two weeks or a month); b) which machines or equipment do they use on the average; c) how often; d) what are the reasons for day-to-day variability? will permit to focus on the most accurate description.

As shown on Figure 4-4 the breakdown required is the equipment or background code followed by the percentage of an eight-hour day the worker either operates an equipment item or spends in a background location. A maximum of ten individual sources can be used to describe the job assignment. Two lines on the data form must be used for each job assignment. If the second line is not required a zero should be entered in Column 27 of that line.

In the assignment of time, background noise is treated in the same manner as equipment sources. When the assignment of a worker to individual equipment sources is completed, the remainder of his working day (8-hours) must be assigned to background noise (when he is not generating noise but is exposed to other sources). This is done by identifying the areas in which he works and using the corresponding background noise code measured earlier.

4. The total percentage of time must add up to 100% if percentages are used and 8 hours if hours and hour fractions are used.

5. Supervisors or workers who do not operate any specific machinery will have all their time assigned to one or more background location codes.

6. If the preceding data is acquired by questioning individual workers, the process is basically the same except that work assignments are given for one individual at a time.

7. For the same job description (and job code) but different job assignment schedules, the information is entered

> by repeating the job code, description and work assignment. The computer program, upon inspecting the input data, will recognize that the same job description contains different assignments and will add a two-digit code to the above. Thus, each job description may be further subdivided (by the computer program) into ninety-nine additional categories if necessary. This is discussed in more detail in Section 3 of this report.

The development of a consistent technique for the acquisition of the personnel work assignment data depends, obviously, on some familiarity with the industry in question but more importantly, on field experience gained in conducting these or similar surveys. The experience gained during the BBN survey showed that individuals relatively inexperienced in this type of work very quickly develop the ability to consistently ask the "right" questions and guide the supervisor or worker so extract the desired information.

Section 5

RESULTS FOR INDUSTRIES SURVEYED

In this section results of the noise exposure analysis are presented for both the Sawmill Industry and Foundry Industry. The results are extrapolated from the average results for several plants in each industry, using as a basis the ratio of total industry population to the total population of the plants in the sample. The accuracy of the extrapolated results is discussed in the next section. The input data used to obtain the results are contained in Appendices C and D. The analysis results for the individual plants are included in Appendices E and F.

For the personnel noise exposure impact results, the personnel categories were divided into subcategories by the computer program whenever two or more sets of input data, involving different equipment types, were found for the same personnel category. These subcategories are identified by an extra two digits on the right of the three digit job code, allowing a maximum of 99 subcategories for each job category. If the two or more lines of data involved the same equipment types, then the results were averaged and not divided into further subcategories. Thus in the following results there are two different types of table for the personnel noise exposure impacts; the first table type presents the results for individual subcategories represented by a five digit code and the second table type presents the results for each three digit personnel category specified in the input data. The results in the second table type are derived from the first by averaging subcategories which belong to the same category and have the same first three digits in their five digit job code.

Similarly there are two table types for the equipment noise impact and priority indices. The first table type corresponds to individual equipment types referred to in the input noise level data. The second table type is for general equipment classifications where the results for all equipment types belonging to a particular classification have been averaged. The equipment types belonging to each general classification are indicated on a separate list -- Tables 5-7 and 5-27.

Finally an example of the effect of noise control, for certain equipment types, on both the personnel exposure impact and equipment priority indices, is included for each industry considered.

5.1 Sawmill Industry Results - SIC 242

The results presented here represent the entire industry and were derived from data collected in nine different plants, all of which were selected at random. An overview of the noise exposure problem is shown in Figure 5-1 which indicates the number of personnel exposed to equivalent eight hour noise levels equal to or greater than the level indicated on the ordinate axis. The results are presented in detail in the tables to follow.

In Tables 5-1 and 5-2 personnel noise exposure impact results are presented for each five digit personnel subcategory. Table 5-1 shows the level weighted population results derived using EPA criteria (see Section 3) and Table 5-2 shows the daily noise dose results derived using OSHA criteria (see Section 3).The title at the top of the table identifies the SIC code for the industry. One line in each table corresponds to a unique personnel subcategory. The categories are rankordered in terms of the magnitude of their exposure impact.

The first column in each table contains a five digit code, the first three of which correspond to the personnel category code

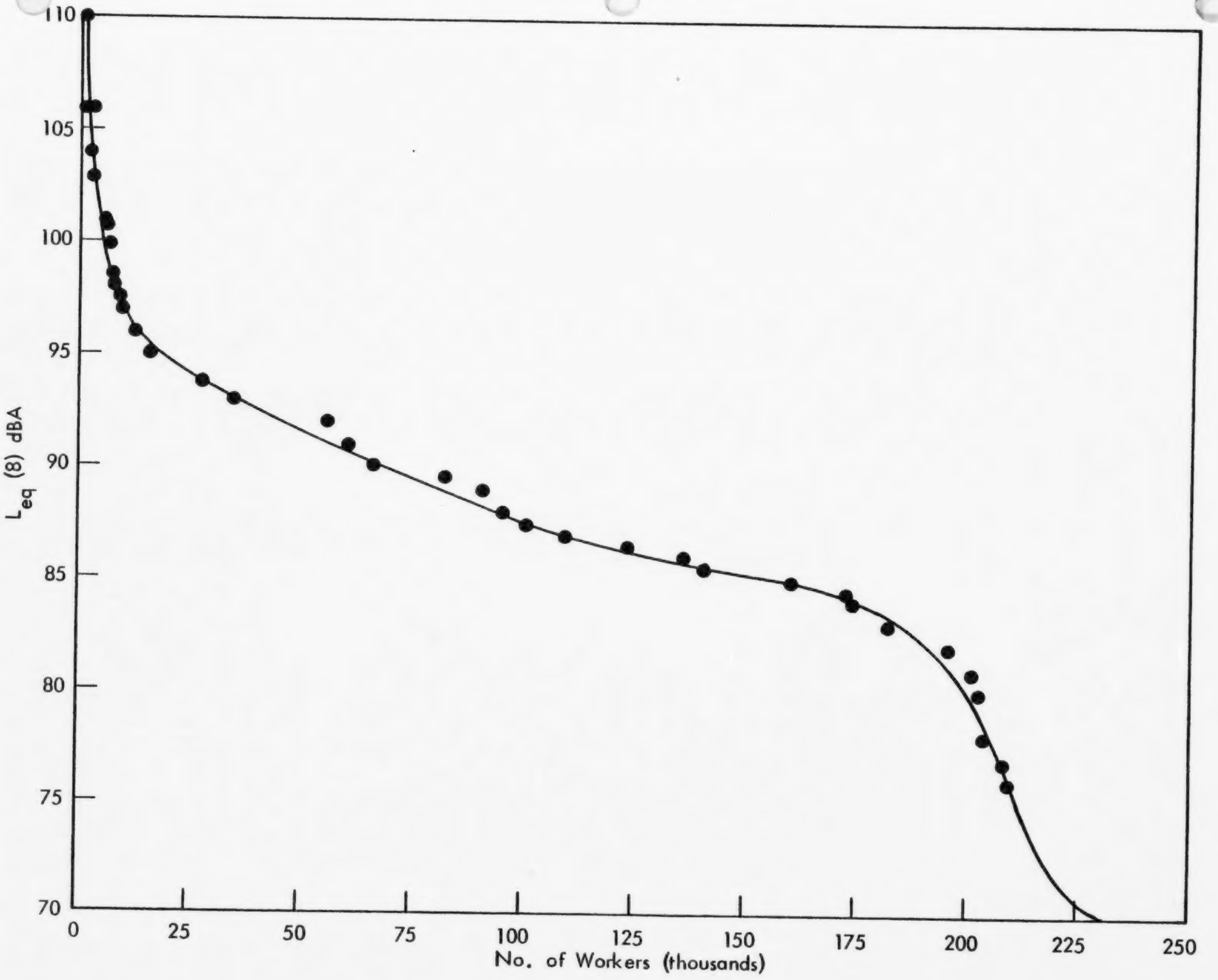


FIGURE 5.1 OVERVIEW OF THE NOISE EXPOSURE PROBLEM IN THE SAWMILL INDUSTRY

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-1 PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
21100	MILLWRIGHT/GENERAL	10252	89.7	91.9	55030	73097
16800	PLANER SET-UP MAN	1537	109.9	113.8	46779	57669
22800	ELECTRICIANS	7689	89.7	91.9	41272	54823
17305	GRADER/PLANER MILL	5126	92.8	95.4	40538	53293
17306	GRADER/PLANER MILL	4100	92.7	94.7	32183	39660
15102	GREEN CHAIN PULLER	3075	95.2	97.3	31530	38276
16702	PLANER OPERATOR	1794	101.1	106.7	30576	45070
13400	EDGER OPERATOR	2819	94.3	103.3	26387	56580
16700	PLANER OPERATOR	2306	94.0	97.6	20857	29410
12700	TAIL SAWYER	1537	97.6	103.8	19668	31915
14000	RESAW OPERATOR	2563	92.2	94.2	18887	23660
16703	PLANER OPERATOR	2050	93.8	96.8	18056	24439
17605	DRY CHAIN PULLER	6663	85.2	85.7	17434	19131
14800	TRIMMER OPERATOR	4357	87.5	95.4	17126	45298
21200	MILLWRIGHT/SAWMILL	2050	93.3	93.7	17074	17881
20203	FORKLIFT OPERATOR	4869	86.6	90.2	16256	26125
21302	MILLWRIGHT/PLANER	768	102.9	106.8	14959	19450
20200	FORKLIFT OPERATOR	5895	84.5	88.4	13361	26333
17606	DRY CHAIN PULLER	5126	85.2	89.1	13332	25307
13701	CHIPPER OPERATOR	768	100.8	104.8	12812	17041
17301	GRADER/PLANER MILL	1537	92.8	92.8	12191	12191
21103	MILLWRIGHT/GENERAL	1281	93.9	94.3	11458	11909
24802	POWERHOUSE OPERATOR	3075	87.0	90.4	10990	18210
16804	PLANER SET-UP MAN	512	104.0	107.7	10766	13723
17601	DRY CHAIN PULLER	3075	86.6	88.7	10395	14407
15400	STACKER-GREEN	3331	86.0	92.0	10082	24146
13401	EDGER OPERATOR	3588	85.5	93.3	9919	30191
16701	PLANER OPERATOR	1025	93.9	97.5	9119	12932
17603	DRY CHAIN PULLER	2563	86.9	89.0	9073	12615
13703	CHIPPER OPERATOR	512	101.2	104.9	8776	11453
21101	MILLWRIGHT/GENERAL	1025	93.3	95.8	8557	11108
21903	MACHINISTS	1281	91.3	91.3	8541	8541
16801	PLANER SET-UP MAN	512	100.4	104.0	8238	10774
21104	MILLWRIGHT/GENERAL	1025	92.8	96.6	8115	11929
14807	TRIMMER OPERATOR	1025	92.7	92.7	8062	8062
16802	PLANER SET-UP MAN	512	99.9	103.6	7928	10624
14402	LUMBER DIVERTER	768	95.0	97.1	7720	9386
20101	LUMBER CARRIER OPER	2819	85.4	87.8	7586	11585
14401	LUMBER DIVERTER	768	94.5	96.5	7301	8863
17600	DRY CHAIN PULLER	4613	82.9	89.0	7240	22089

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-1 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
13801	HOG OPERATOR	512	98.5	101.6	7090	9082
12300	SAWYER	4869	82.6	87.0	7030	17646
15101	GREEN CHAIN PULLER	2306	86.0	90.2	6946	13279
13702	CHIPPER OPERATOR	512	98.0	101.4	6764	8905
22804	ELECTRICIANS	1281	89.2	89.6	6435	6863
22803	ELECTRICIANS	768	93.3	93.7	6404	6707
12800	QUADSAW TAIL SAWYER	512	97.0	97.0	6202	6202
16803	PLANER SET-UP MAN	256	106.0	109.8	6140	7777
10102	SAWMILL SUPERVISOR	768	92.9	93.3	6133	6456
10401	PLANER SUPERVISOR	768	92.9	93.3	6133	6456
14806	TRIMMER OPERATOR	1025	90.4	93.1	6054	8424
26106	CLEAN-UP MAN/REGULAR	512	96.7	100.3	6029	8171
21202	MILLWRIGHT/SAWMILL	768	92.7	93.2	6027	6358
20201	FORKLIFT OPERATOR	1794	86.6	90.2	5989	10362
15403	STACKER-GREEN	1794	86.4	92.7	5841	14079
21201	MILLWRIGHT/SAWMILL	1025	90.0	91.6	5737	7091
13700	CHIPPER OPERATOR	512	95.6	100.4	5459	8271
10402	PLANER SUPERVISOR	1025	89.5	91.6	5422	7022
14802	TRIMMER OPERATOR	768	91.8	94.8	5397	7564
10101	SAWMILL SUPERVISOR	768	91.6	92.8	5316	6115
14804	TRIMMER OPERATOR	768	91.6	95.0	5300	7715
23303	CARPENTERS	1025	89.2	90.1	5173	5830
14503	GREEN CHAIN OPERATOR	1537	86.5	91.0	5054	9803
15100	GREEN CHAIN PULLER	1537	86.5	91.0	5054	9803
15500	STICKERMAN-GREEN	2050	84.9	90.7	5044	12623
19100	SPECIALTY RESAW OFFB	512	94.7	97.9	4956	6709
11701	DECK SCALER	512	94.1	94.6	4662	4929
16100	UNSTACKER-DRY	1025	88.4	92.1	4621	7471
10103	SAWMILL SUPERVISOR	512	93.9	94.3	4583	4763
24502	OILER	512	93.9	94.3	4583	4763
13802	HOG OPERATOR	512	93.4	94.5	4359	4673
17304	GRADER/PLANER MILL	2306	83.7	86.8	4331	10906
21301	MILLWRIGHT/PLANER	768	90.0	91.8	4325	5454
17604	DRY CHAIN PULLER	1025	87.9	90.0	4291	5784
24501	OILER	512	93.3	95.8	4278	5554
10400	PLANER SUPERVISOR	768	89.9	90.9	4272	4886
23300	CARPENTERS	512	93.1	93.6	4210	4416
12301	SAWYER	1025	87.8	87.8	4180	4180
20100	LUMBER CARRIER OPER	2306	83.5	85.2	4170	7219
15900	TRANSFER OPERATOR	768	89.7	105.0	4147	17316

TABLE 5-1 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
26501	LABORER	512	92.8	95.6	4082	5431
26602	HELPER	512	92.8	95.6	4082	5431
20204	FORKLIFT OPERATOR	1281	86.1	89.4	3929	6687
13300	SLAB BOARD PULLER	512	92.5	93.2	3924	4248
22801	ELECTRICIANS	512	92.5	95.4	3909	5327
10104	SAWMILL SUPERVISOR	768	89.0	90.3	3788	4521
14302	UNSCRAMBLE OPERATOR	512	92.0	95.5	3703	5366
24401	FILERS	3588	81.2	85.8	3411	10492
21102	MILLWRIGHT/GENERAL	512	91.3	91.6	3405	3548
15501	STICKERMAN-GREEN	1281	85.2	91.3	3315	6504
10100	SAWMILL SUPERVISOR	512	91.0	91.4	3299	3448
24400	FILERS	512	90.9	91.3	3247	3398
16200	UNSTACKER PULLER	2050	82.9	89.0	3217	10084
26202	CLEAN-UP MAN/DOWN TM	768	87.8	90.9	3149	4666
12000	CUT-OFF SAW OPERATOR	512	90.6	92.6	3109	3965
14803	TRIMMER OPERATOR	768	87.5	95.7	3005	6239
26101	CLEAN-UP MAN/REGULAR	512	90.3	91.4	2996	3454
19000	SPECIALTY RESAW OPER	256	96.5	103.1	2961	5062
19102	SPECIALTY RESAW OFFB	512	90.0	91.4	2863	3452
15402	STACKER-GREEN	1281	84.5	90.3	2876	7545
26600	HELPER	1537	83.5	87.2	2807	5711
24500	OILER	512	89.6	90.4	2734	3044
16102	UNSTACKER-DRY	512	89.4	90.1	2640	2917
26103	CLEAN-UP MAN/REGULAR	512	89.2	90.5	2596	3071
23801	PIPE-FITTERS	512	89.2	90.1	2586	2915
13803	HOG OPERATOR	256	95.0	100.6	2560	4214
19001	SPECIALTY RESAW OPER	256	94.6	100.4	2464	4123
19101	SPECIALTY RESAW OFFB	256	94.6	100.4	2464	4123
20202	FORKLIFT OPERATOR	768	86.3	88.6	2443	3545
15901	TRANSFER OPERATOR	512	88.8	103.6	2433	10460
18200	TALLYMEN	768	86.2	93.0	2411	6251
17901	BANDER OPERATOR	512	88.6	89.7	2368	2772
18100	CHECKERS	1537	82.8	85.[illegible]	2359	4277
18500	RIPSAW OPERATOR	256	94.0	94.0	2313	2313
16300	GRADER/SORTING CHAIN	512	88.4	92.1	2310	3735
16201	UNSTACKER PULLER	768	86.0	86.8	2305	3665
14400	LUMBER DIVERTER	256	93.5	95.7	2203	2756
19002	SPECIALTY RESAW OPER	512	88.0	90.8	2165	3210
23302	CARPENTERS	256	93.3	93.7	2134	2235
14805	TRIMMER OPERATOR	512	87.7	95.9	2075	5611

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-1 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
14801	TRIMMER OPERATOR	256	92.8	95.3	2035	2646
11700	DECK SCALER	512	87.5	92.5	2002	3924
26105	CLEAN-UP MAN/REGULAR	256	92.6	94.6	1974	2452
23301	CARPENTERS	256	92.5	95.4	1954	2663
26603	HELPER	256	92.5	95.4	1954	2663
18202	TALLYMEN	1025	83.7	88.8	1925	4847
18600	RIPSAW OFFBEARER	256	92.0	92.0	1851	1851
13800	HOG OPERATOR	256	92.0	92.5	1851	1956
24801	POWERHOUSE OPERATOR	768	84.7	87.7	1796	3111
24800	POWERHOUSE OPERATOR	768	84.6	87.6	1779	3045
22802	ELECTRICIANS	256	91.1	91.4	1658	1731
14301	UNSCRAMBLE OPERATOR	512	86.2	90.6	1615	3114
18201	TALLYMEN	512	86.0	92.6	1551	3983
15404	STACKER-GREEN	512	85.5	91.1	1402	3313
17302	GRADER/PLANER MILL	256	89.8	92.4	1398	1936
15600	UNIPAC OPERATOR	512	85.4	88.3	1397	2274
15503	STICKERMAN-GREEN	512	85.4	91.8	1393	3626
16001	KILN OPERATOR	512	85.3	88.8	1363	2435
26504	LABORER	256	89.5	89.5	1348	1348
23800	PIPE-FITTERS	256	89.4	89.4	1331	1331
19600	MOULDER FEEDER	256	89.3	89.3	1316	1316
14500	GREEN CHAIN OPERATOR	512	85.1	88.6	1311	2377
14502	GREEN CHAIN OPERATOR	512	84.9	89.4	1260	2664
26104	CLEAN-UP MAN/REGULAR	256	88.9	89.2	1242	1295
15502	STICKERMAN-GREEN	512	84.7	90.2	1201	2975
24402	FILERS	1281	80.9	85.6	1131	3594
11403	DEBARKER OPERATOR	256	88.1	88.1	1106	1106
17300	GRADER/PLANER MILL	256	88.0	94.1	1082	2333
26503	LABORER	256	87.8	89.6	1046	1370
21600	SHOPMAN/GENERAL	256	87.7	88.9	1030	1234
18204	TALLYMEN	256	87.5	89.8	1003	1396
19601	MOULDER FEEDER	512	83.7	88.5	969	2347
26100	CLEAN-UP MAN/REGULAR	256	87.3	89.2	965	1285
11101	LOG CARRIER OPER	256	87.0	87.0	921	921
26200	CLEAN-UP MAN/DOWN TM	256	87.0	88.9	915	1245
17902	BANDER OPERATOR	512	83.3	84.9	889	1246
17903	BANDER OPERATOR	768	81.7	82.9	859	1185
26102	CLEAN-UP MAN/REGULAR	256	86.3	88.0	813	1087
16301	GRADER/SORTING CHAIN	256	86.0	90.2	779	1479
19700	MOULDER OFFBEARER	768	81.3	88.0	771	3244

TABLE 5-1 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
16101	UNSTACKER-DRY	256	86.0	88.8	768	1221
21300	MILLWRIGHT/PLANER	256	85.6	86.7	720	879
15401	STACKER-GREEN	256	85.0	87.9	639	1060
17602	DRY CHAIN PULLER	256	85.0	87.4	638	980
17303	GRADER/PLANER MILL	256	84.6	86.6	596	860
14300	UNSCRAMBLE OPERATOR	256	84.5	85.1	574	795
14501	GREEN CHAIN OPERATOR	256	84.3	85.6	551	725
16003	KILN OPERATOR	256	84.0	84.0	517	517
12701	TAIL SAWYER	256	82.8	87.3	390	965
16002	KILN OPERATOR	256	82.7	89.0	379	1252
16000	KILN OPERATOR	1025	78.7	85.0	349	2542
11404	DEBARKER OPERATOR	2050	77.6	83.6	334	3819
26502	LABORER	256	81.9	84.6	301	587
13100	GANG SAW OPERATOR	1025	77.9	79.2	208	456
11405	DEBARKER OPERATOR	512	78.3	85.0	138	1290
11401	DEBARKER OPERATOR	512	77.8	84.2	103	1081
11402	DEBARKER OPERATOR	512	77.5	83.9	78	1011
15103	GREEN CHAIN PULLER	512	76.0	75.0	12	12
14001	RESAW OPERATOR	512	<75.0	<75.0	0	0
11400	DEBARKER OPERATOR	512	<75.0	79.8	0	292
20701	RAILCAR LOADER	2819	<75.0	79.3	0	1318
21900	MACHINISTS	512	<75.0	75.7	0	175
11406	DEBARKER OPERATOR	512	<75.0	<75.0	0	0
21902	MACHINISTS	2050	<75.0	<75.0	0	0
22300	MECHANICS	2050	<75.0	<75.0	0	0
10700	POND SORTER	1537	<75.0	<75.0	0	0
10800	LOG SORTER	512	<75.0	<75.0	0	0
11100	LOG CARRIER OPER	256	<75.0	<75.0	0	0
16004	KILN OPERATOR	768	<75.0	<75.0	0	0
17900	BANDER OPERATOR	512	<75.0	<75.0	0	0
18203	TALLYMEN	1537	<75.0	<75.0	0	0
20700	RAILCAR LOADER	512	<75.0	<75.0	0	0
21700	WELDER	256	<75.0	<75.0	0	0
21901	MACHINISTS	1025	<75.0	<75.0	0	0
22301	MECHANICS	3844	<75.0	<75.0	0	0
24403	FILERS	1537	<75.0	<75.0	0	0
26201	CLEAN-UP MAN/DOWN TM	1025	<75.0	<75.0	0	0
26500	LABORER	512	<75.0	<75.0	0	0
26601	HELPER	256	<75.0	<75.0	0	0

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-2 PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
16800	PLANER SET-UP MAN	1537	108.4	112.1	12.74	21.38
16803	PLANER SET-UP MAN	256	102.3	105.8	5.52	8.98
16804	PLANER SET-UP MAN	512	100.5	103.3	4.28	6.35
13703	CHIPPER OPERATOR	512	100.3	103.9	4.19	6.82
13701	CHIPPER OPERATOR	768	99.0	103.2	3.50	6.24
16702	PLANER OPERATOR	1794	97.9	102.2	2.98	5.44
12700	TAIL SAWYER	1537	97.6	103.7	2.87	6.66
12800	QUADSAW TAIL SAWYER	512	97.0	97.0	2.64	2.64
21302	MILLWRIGHT/PLANER	768	96.7	100.5	2.53	4.26
19000	SPECIALTY RESAW OPER	256	96.5	103.1	2.46	6.15
13801	HOG OPERATOR	512	96.0	98.8	2.30	3.40
13702	CHIPPER OPERATOR	512	95.8	98.7	2.25	3.35
15102	GREEN CHAIN PULLER	3075	95.3	97.3	2.07	2.76
16801	PLANER SET-UP MAN	512	95.0	97.6	1.99	2.85
14402	LUMBER DIVERTER	768	94.9	95.9	1.97	2.62
19100	SPECIALTY RESAW OFFB	512	94.7	97.9	1.91	2.98
13700	CHIPPER OPERATOR	512	94.3	97.2	1.81	2.72
18500	RIPSAW OPERATOR	256	94.0	94.0	1.74	1.74
16700	PLANER OPERATOR	2306	94.0	97.5	1.74	2.83
19001	SPECIALTY RESAW OPER	256	94.0	99.2	1.73	3.58
19101	SPECIALTY RESAW OFFB	256	94.0	99.2	1.73	3.58
11701	DECK SCALER	512	93.9	94.2	1.73	1.80
16703	PLANER OPERATOR	2050	93.7	96.6	1.68	2.51
16701	PLANER OPERATOR	1025	93.7	97.3	1.67	2.74
14401	LUMBER DIVERTER	768	93.6	95.7	1.66	2.20
14400	LUMBER DIVERTER	256	93.5	95.7	1.63	2.20
13802	HOG OPERATOR	512	93.3	94.2	1.57	1.79
24501	OILER	512	93.2	95.1	1.56	2.03
21101	MILLWRIGHT/GENERAL	1025	93.2	95.1	1.56	2.03
10103	SAWMILL SUPERVISOR	512	93.0	93.4	1.52	1.60
24502	OILER	512	93.0	93.4	1.52	1.60
21103	MILLWRIGHT/GENERAL	1281	93.0	93.4	1.52	1.60
13400	EDGER OPERATOR	2819	93.0	102.5	1.52	5.64
13803	HOG OPERATOR	256	93.0	98.7	1.52	3.32
17301	GRADER/PLANER MILL	1537	92.8	92.8	1.48	1.48
17305	GRADER/PLANER MILL	5126	92.8	95.4	1.47	2.11

ENVIRONMENTAL PROTECTION AGENCY

BBN JOB NO. 9635

TABLE 5-2 PERSONNEL NOISE EXPOSURE AND IMPACT
(Cont'd)

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL		DAILY NOISE DOSE	
			MEAN	W.C.	MEAN	W.C.
17306	GRADER/PLANER MILL	4100	92.7	94.7	1.46	1.91
21200	MILLWRIGHT/SAWMILL	2050	92.6	92.9	1.43	1.50
26105	CLEAN-UP MAN/REGULAR	256	92.6	94.6	1.43	1.88
13300	SLAB BOARD PULLER	512	92.5	93.2	1.41	1.56
22803	ELECTRICIANS	768	92.5	92.8	1.41	1.48
23302	CARPENTERS	256	92.5	92.8	1.41	1.48
21104	MILLWRIGHT/GENERAL	1025	92.3	96.1	1.38	2.33
14302	UNSCRAMBLE OPERATOR	512	92.0	95.5	1.32	2.13
18600	RIPSAW OFFBEARER	256	92.0	92.0	1.32	1.32
10102	SAWMILL SUPERVISOR	768	92.0	92.4	1.32	1.39
10401	PLANER SUPERVISOR	768	92.0	92.4	1.32	1.39
23300	CARPENTERS	512	92.0	92.4	1.32	1.39
14801	TRIMMER OPERATOR	256	91.9	94.5	1.31	1.88
14802	TRIMMER OPERATOR	768	91.7	94.7	1.27	1.92
22801	ELECTRICIANS	512	91.7	94.0	1.27	1.75
26501	LABORER	512	91.7	94.0	1.27	1.75
26602	HELPER	512	91.7	94.0	1.27	1.75
23301	CARPENTERS	256	91.7	94.0	1.27	1.75
26603	HELPER	256	91.7	94.0	1.27	1.75
26106	CLEAN-UP MAN/REGULAR	512	91.5	95.4	1.23	2.11
14804	TRIMMER OPERATOR	768	91.2	94.7	1.19	1.92
16802	PLANER SET-UP MAN	512	91.2	95.2	1.18	2.05
14000	RESAW OPERATOR	2563	90.7	93.1	1.11	1.54
21202	MILLWRIGHT/SAWMILL	768	90.7	91.1	1.10	1.17
10101	SAWMILL SUPERVISOR	768	90.6	91.7	1.09	1.27
13800	HOG OPERATOR	256	90.1	90.6	1.02	1.08
14807	TRIMMER OPERATOR	1025	90.0	90.0	1.00	1.00
21903	MACHINISTS	1281	<90.0	<90.0	0.96	0.96
21102	MILLWRIGHT/GENERAL	512	<90.0	<90.0	0.88	0.91
22802	ELECTRICIANS	256	<90.0	<90.0	0.88	0.91
26101	CLEAN-UP MAN/REGULAR	512	<90.0	90.1	0.88	1.01
10100	SAWMILL SUPERVISOR	512	<90.0	<90.0	0.82	0.86
24400	FILERS	512	<90.0	<90.0	0.82	0.86
15900	TRANSFER OPERATOR	768	<90.0	104.0	0.80	6.95
10400	PLANER SUPERVISOR	768	<90.0	<90.0	0.80	0.92
17302	GRADER/PLANER MILL	256	<90.0	90.4	0.74	1.06

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-2 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL		DAILY NOISE DOSE	
			MEAN	W.C.	MEAN	W.C.
21201	MILLWRIGHT/SAWMILL	1025	<90.0	<90.0	0.73	0.90
21100	MILLWRIGHT/GENERAL	10252	<90.0	<90.0	0.72	0.94
22800	ELECTRICIANS	7689	<90.0	<90.0	0.72	0.94
10402	PLANER SUPERVISOR	1025	<90.0	<90.0	0.71	0.94
21301	MILLWRIGHT/PLANER	768	<90.0	<90.0	0.71	0.94
14806	TRIMMER OPERATOR	1025	<90.0	90.5	0.66	1.07
26504	LABORER	256	<90.0	<90.0	0.64	0.64
15901	TRANSFER OPERATOR	512	<90.0	101.6	0.57	4.96
23801	PIPE-FITTERS	512	<90.0	<90.0	0.55	0.62
23303	CARPENTERS	1025	<90.0	<90.0	0.55	0.62
23800	PIPE-FITTERS	256	<90.0	<90.0	0.52	0.52
17901	BANDER OPERATOR	512	<90.0	<90.0	0.50	0.59
10104	SAWMILL SUPERVISOR	768	<90.0	<90.0	0.49	0.60
26103	CLEAN-UP MAN/REGULAR	512	<90.0	<90.0	0.49	0.60
21600	SHOPMAN/GENERAL	256	<90.0	<90.0	0.44	0.51
26503	LABORER	256	<90.0	<90.0	0.43	0.56
19600	MOULDER FEEDER	256	<90.0	<90.0	0.40	0.40
11403	DEBARKER OPERATOR	256	<90.0	<90.0	0.39	0.39
22804	ELECTRICIANS	1281	<90.0	<90.0	0.39	0.42
24500	OILER	512	<90.0	<90.0	0.38	0.45
12000	CUT-OFF SAW OPERATOR	512	<90.0	<90.0	0.36	0.52
21300	MILLWRIGHT/PLANER	256	<90.0	<90.0	0.31	0.36
26102	CLEAN-UP MAN/REGULAR	256	<90.0	<90.0	0.29	0.38
26104	CLEAN-UP MAN/REGULAR	256	<90.0	<90.0	0.27	0.29
17604	DRY CHAIN PULLER	1025	<90.0	<90.0	0.22	0.39
18204	TALLYMEN	256	<90.0	<90.0	0.22	0.39
16102	UNSTACKER-DRY	512	<90.0	<90.0	0.21	0.28
26200	CLEAN-UP MAN/DOWN TM	256	<90.0	<90.0	0.16	0.29
10700	POND SORTER	1537	<90.0	<90.0	0.00	0.0
10800	LOG SORTER	512	<90.0	<90.0	0.00	0.0
11100	LOG CARRIER OPER	256	<90.0	<90.0	0.00	0.0
11101	LOG CARRIER OPER	256	<90.0	<90.0	0.00	0.0
11400	DEBARKER OPERATOR	512	<90.0	<90.0	0.00	0.0
11401	DEBARKER OPERATOR	512	<90.0	<90.0	0.00	0.0
11402	DEBARKER OPERATOR	512	<90.0	<90.0	0.00	0.0
11404	DEBARKER OPERATOR	2050	<90.0	<90.0	0.00	0.0

TABLE 5-2 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL		DAILY NOISE DOSE	
			MEAN	W.C.	MEAN	W.C.
11405	DEBARKER OPERATOR	512	<90.0	<90.0	0.00	0.0
11406	DEBARKER OPERATOR	512	<90.0	<90.0	0.00	0.0
11700	DECK SCALER	512	<90.0	92.5	0.00	1.41
12300	SAWYER	4869	<90.0	<90.0	0.00	0.0
12301	SAWYER	1025	<90.0	<90.0	0.00	0.0
12701	TAIL SAWYER	256	<90.0	<90.0	0.00	0.0
13100	GANG SAW OPERATOR	1025	<90.0	<90.0	0.00	0.0
13401	EDGER OPERATOR	3568	<90.0	92.7	0.00	1.45
14001	RESAW OPERATOR	512	<90.0	<90.0	0.00	0.0
14300	UNSCRAMBLE OPERATOR	256	<90.0	<90.0	0.00	0.0
14301	UNSCRAMBLE OPERATOR	512	<90.0	90.2	0.00	1.03
14500	GREEN CHAIN OPERATOR	512	<90.0	<90.0	0.00	0.57
14501	GREEN CHAIN OPERATOR	256	<90.0	<90.0	0.00	0.0
14502	GREEN CHAIN OPERATOR	512	<90.0	<90.0	0.00	0.80
14503	GREEN CHAIN OPERATOR	1537	<90.0	91.0	0.00	1.14
14800	TRIMMER OPERATOR	4357	<90.0	94.9	0.00	1.98
14803	TRIMMER OPERATOR	768	<90.0	95.6	0.00	2.16
14805	TRIMMER OPERATOR	512	<90.0	95.9	0.00	2.27
15100	GREEN CHAIN PULLER	1537	<90.0	91.0	0.00	1.14
15101	GREEN CHAIN PULLER	2306	<90.0	<90.0	0.00	0.91
15103	GREEN CHAIN PULLER	512	<90.0	<90.0	0.00	0.0
15400	STACKER-GREEN	3331	<90.0	91.4	0.00	1.21
15401	STACKER-GREEN	256	<90.0	<90.0	0.00	0.0
15402	STACKER-GREEN	1281	<90.0	<90.0	0.00	0.77
15403	STACKER-GREEN	1794	<90.0	92.7	0.00	1.46
15404	STACKER-GREEN	512	<90.0	<90.0	0.00	0.95
15500	STICKERMAN-GREEN	2050	<90.0	<90.0	0.00	0.94
15501	STICKERMAN-GREEN	1281	<90.0	90.8	0.00	1.12
15502	STICKERMAN-GREEN	512	<90.0	<90.0	0.00	0.84
15503	STICKERMAN-GREEN	512	<90.0	91.8	0.00	1.29
15600	UNIPAC OPERATOR	512	<90.0	<90.0	0.00	0.0
16000	KILN OPERATOR	1025	<90.0	<90.0	0.00	0.0
16001	KILN OPERATOR	512	<90.0	<90.0	0.00	0.72
16002	KILN OPERATOR	256	<90.0	<90.0	0.00	0.0
16003	KILN OPERATOR	256	<90.0	<90.0	0.00	0.0
16004	KILN OPERATOR	768	<90.0	<90.0	0.00	0.0

TABLE 5-2 PERSONNEL NOISE EXPOSURE AND IMPACT
(Cont'd)

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL		DAILY NOISE DOSE	
			MEAN	H.C.	MEAN	H.C.
16100	UNSTACKER-DRY	1025	<90.0	92.1	0.00	1.33
16101	UNSTACKER-DRY	256	<90.0	<90.0	0.00	0.53
16200	UNSTACKER PULLER	2050	<90.0	<90.0	0.00	0.0
16201	UNSTACKER PULLER	768	<90.0	<90.0	0.00	0.53
16300	GRADER/SORTING CHAIN	512	<90.0	92.1	0.00	1.33
16301	GRADER/SORTING CHAIN	256	<90.0	<90.0	0.00	0.91
17300	GRADER/PLANER MILL	256	<90.0	94.1	0.00	1.76
17303	GRADER/PLANER MILL	256	<90.0	<90.0	0.00	0.0
17304	GRADER/PLANER MILL	2306	<90.0	<90.0	0.00	0.0
17600	DRY CHAIN PULLER	4613	<90.0	<90.0	0.00	0.0
17601	DRY CHAIN PULLER	3075	<90.0	<90.0	0.00	0.0
17602	DRY CHAIN PULLER	256	<90.0	<90.0	0.00	0.0
17603	DRY CHAIN PULLER	2563	<90.0	<90.0	0.00	0.0
17605	DRY CHAIN PULLER	6663	<90.0	<90.0	0.00	0.0
17606	DRY CHAIN PULLER	5126	<90.0	<90.0	0.00	0.0
17900	BANDER OPERATOR	512	<90.0	<90.0	0.00	0.0
17902	BANDER OPERATOR	512	<90.0	<90.0	0.00	0.0
17903	BANDER OPERATOR	768	<90.0	<90.0	0.00	0.0
18100	CHECKERS	1537	<90.0	<90.0	0.00	0.0
18200	TALLYMEN	768	<90.0	93.0	0.00	1.52
18201	TALLYMEN	512	<90.0	92.3	0.00	1.37
18202	TALLYMEN	1025	<90.0	<90.0	0.00	0.0
18203	TALLYMEN	1537	<90.0	<90.0	0.00	0.0
19002	SPECIALTY RESAW OPER	512	<90.0	90.8	0.00	1.12
19102	SPECIALTY RESAW OFFB	512	<90.0	91.4	0.00	1.22
19601	MOULDER FEEDER	512	<90.0	<90.0	0.00	0.0
19700	MOULDER OFFBEARER	768	<90.0	<90.0	0.00	0.0
20100	LUMBER CARRIER OPER	2306	<90.0	<90.0	0.00	0.0
20101	LUMBER CARRIER OPER	2819	<90.0	<90.0	0.00	0.0
20200	FORKLIFT OPERATOR	5895	<90.0	<90.0	0.00	0.0
20201	FORKLIFT OPERATOR	1794	<90.0	90.2	0.00	0.67
20202	FORKLIFT OPERATOR	768	<90.0	<90.0	0.00	1.03
20203	FORKLIFT OPERATOR	4869	<90.0	90.2	0.00	0.51
20204	FORKLIFT OPERATOR	1281	<90.0	<90.0	0.00	1.03
20700	RAILCAR LOADER	512	<90.0	<90.0	0.00	0.82
20701	RAILCAR LOADER	2819	<90.0	<90.0	0.00	0.0

TABLE 5-2 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
21700	WELDER	256	<90.0	<90.0	0.00	0.0
21900	MACHINISTS	512	<90.0	<90.0	0.00	0.0
21901	MACHINISTS	1025	<90.0	<90.0	0.00	0.0
21902	MACHINISTS	2050	<90.0	<90.0	0.00	0.0
22300	MECHANICS	2050	<90.0	<90.0	0.00	0.0
22301	MECHANICS	3844	<90.0	<90.0	0.00	0.0
24401	FILERS	3588	<90.0	<90.0	0.00	0.0
24402	FILERS	1281	<90.0	<90.0	0.00	0.0
24403	FILERS	1537	<90.0	<90.0	0.00	0.0
24800	POWERHOUSE OPERATOR	768	<90.0	<90.0	0.00	0.0
24801	POWERHOUSE OPERATOR	768	<90.0	<90.0	0.00	0.0
24802	POWERHOUSE OPERATOR	3075	<90.0	<90.0	0.00	0.70
26100	CLEAN-UP MAN/REGULAR	256	<90.0	<90.0	0.00	0.33
26201	CLEAN-UP MAN/DOWN TM	1025	<90.0	<90.0	0.00	0.0
26202	CLEAN-UP MAN/DOWN TM	768	<90.0	90.9	0.00	1.14
26500	LABORER	512	<90.0	<90.0	0.00	0.0
26502	LABORER	256	<90.0	<90.0	0.00	0.0
26600	HELPER	1537	<90.0	<90.0	0.00	0.51
26601	HELPER	256	<90.0	<90.0	0.00	0.0

used in the input data. The last two digits have been added to separate out personnel who belong to the same personnel category (represented by a three digit code) but who have job assignments involving different equipment types.

The second column labeled "job description" is a brief 20-letter description of the three-digit job category from which the subcategory was derived. The next column indicates the number of personnel to be found in the subcategory described in the previous two columns.

The fourth and fifth columns labeled "sound level" correspond to the mean and estimated worst case equivalent eight-hour sound levels for each subcategory. The equivalent eight-hour sound level is the continuous sound level which would result in the same exposure in an eight-hour period for the particular personnel subcategory. This quantity is identified as the "mean sound level" in the tables and is calculated differently, depending on whether EPA or OSHA criteria are used. Thus the numbers in these columns cannot be expected to agree for the same subcategory in Tables 5-1 and 5-2. As explained in Section 3, the worst case estimate is derived from the mean using both the standard deviation for the sound level measurements and the standard deviation for the time allocated to each job assignment. In some cases there is insufficient data to allow valid calculation of the worst case; in these instances the worst case estimate is the same as the mean.

The sixth and seventh columns in Tables 5-1 and 5-2 are a measure of the personnel noise exposure impact, calculated using EPA criteria in Table 5-1 (Level Weighted Population - LWP_i) and OSHA criteria in Table 5-2 (Daily Noise Dose - d_i). Again the worst case is calculated from the mean in a similar way to that decribed for the equivalent eight-hour sound level.

As expected the results obtained using the two criteria are not in agreement. The disagreement is attributed to the following reasons:

1. OSHA criteria does not take into account the number of people in each personnel category whereas EPA does.
2. EPA criteria takes into account sound levels between 75 dBA and 90 dBA when calculating exposure; OSHA criteria does not.
3. EPA criteria uses an equivalence of 3 dBA for halving of the exposure time; OSHA uses 5 dBA.

In Tables 5-3 and 5-4 the results for the individual personnel subcategories having five-digit job codes are combined into categories with three-digit job codes by averaging subcategories with the same first three digits. The resulting personnel categories correspond to the categories in the program input data and the corresponding results are simpler to interpret than the more detailed results of Tables 5-1 and 5-2. Tables 5-3 and 5-4 have the same arrangement as Tables 5-1 and 5-2 and no further explanation of items contained in the table is necessary. The personnel categories are rank ordered in terms of their exposure impact, allowing the most important categories to be seen at a glance. As expected, different results are obtained when the OSHA criteria are used in place of the EPA criteria.

Beneath each of Tables 5-3 and 5-4 is a summary of the results showing the number of people overexposed. For reasons listed earlier the number of people with an equivalent eight-hour sound level in excess of 90 dBA (calculated using EPA criteria) is not in agreement with the number of people overexposed, calculated using OSHA criteria (daily noise dose greater than 1.0).

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TABLE 5-3 PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. POP. MEAN	W.C.
173	GRADER/PLANER MILL	13837	91.0	93.6	92323	121382
211	MILLWRIGHT/GENERAL	14095	90.6	92.7	86567	111593
168	PLANER SET-UP MAN	3329	105.7	109.5	79853	100769
167	PLANER OPERATOR	7175	95.7	99.6	78610	111653
176	DRY CHAIN PULLER	23321	85.3	88.1	62407	100916
228	ELECTRICIANS	10506	90.0	91.9	59679	75452
148	TRIMMER OPERATOR	9479	89.2	94.8	49056	93561
151	GREEN CHAIN PULLER	7430	89.2	92.3	43544	61372
202	FORKLIFT OPERATOR	14607	85.7	89.3	41980	75054
134	EDGER OPERATOR	6407	89.4	97.7	36306	86772
137	CHIPPER OPERATOR	2304	99.1	103.1	33812	45672
212	MILLWRIGHT/SAWMILL	3843	92.3	93.0	28839	31331
101	SAWMILL SUPERVISOR	3328	91.6	92.4	23122	25305
154	STACKER-GREEN	7174	85.8	91.7	20841	50144
127	TAIL SAWYER	1793	95.5	101.5	20058	32680
213	MILLWRIGHT/PLANER	1792	94.9	97.5	20005	25783
140	RESAW OPERATOR	3075	89.1	90.9	18887	23680
144	LUMBER DIVERTER	1792	94.6	96.6	17226	21006
261	CLEAN-UP MAN/REGULAR	2560	90.7	92.5	16617	20817
138	HOG OPERATOR	1536	95.2	97.6	15862	20126
104	PLANER SUPERVISOR	2561	90.6	91.9	15828	18367
248	POWERHOUSE OPERATOR	4611	86.2	89.5	14566	24367
233	CARPENTERS	2049	91.1	92.1	13473	15146
201	LUMBER CARRIER OPER	5125	84.5	87.1	11757	18804
245	OILER	1536	92.3	93.5	11596	13362
123	SAWYER	5894	83.5	87.2	11210	21827
155	STICKERMAN-GREEN	4355	85.0	90.9	10955	27729
191	SPECIALTY RESAW OFFB	1280	92.8	95.8	10304	14285
266	HELPER	2561	84.4	87.5	8843	13807
219	MACHINISTS	4868	<75.0	77.5	8541	8716
145	GREEN CHAIN OPERATOR	2817	85.7	89.8	8178	15571
161	UNSTACKER-DRY	1793	88.3	91.0	8031	11610
244	FILERS	6918	78.3	81.6	7790	17485
190	SPECIALTY RESAW OPER	1024	91.8	96.3	7592	12396
182	TALLYMEN	4098	77.7	81.2	6891	16479
265	LABORER	1792	82.1	83.6	6779	8739
117	DECK SCALER	1024	90.8	93.6	6665	6853
159	TRANSFER OPERATOR	1280	89.3	104.4	6580	27777
128	QUADSAW TAIL SAWYER	512	97.0	97.0	6202	6202
143	UNSCRAMBLE OPERATOR	1280	88.2	91.6	5893	9276

TABLE 5-3 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
162	UNSTACKER PULLER	2818	83.7	89.0	5523	13749
179	BANDER OPERATOR	2304	79.9	80.9	4117	5203
262	CLEAN-UP MAN/DOWN TM	2049	76.3	77.7	4065	6113
133	SLAB BOARD PULLER	512	92.5	93.2	3924	4248
238	PIPE-FITTERS	768	89.3	89.9	3918	4247
120	CUT-OFF SAW OPERATOR	512	90.6	92.6	3109	3965
163	GRADER/SORTING CHAIN	768	87.6	91.4	3090	5215
160	KILN OPERATOR	2817	77.0	80.5	2609	6747
181	CHECKERS	1537	82.8	85.5	2359	4277
185	RIPSAW OPERATOR	256	94.0	94.0	2313	2313
196	MOULDER FEEDER	768	85.6	88.8	2286	3664
186	RIPSAW OFFBEARER	256	92.0	92.0	1851	1851
114	DEBARKER OPERATOR	4866	77.0	82.3	1762	8602
156	UNIPAC OPERATOR	512	85.4	88.3	1397	22[illegible]
216	SHOPMAN/GENERAL	256	87.7	88.9	1030	1234
111	LOG CARRIER OPER	512	76.0	76.0	921	921
197	MOULDER OFFBEARER	768	81.3	88.0	771	3244
131	GANG SAW OPERATOR	1025	77.9	79.2	208	456
207	RAILCAR LOADER	3331	<75.0	77.1	0	1318
223	MECHANICS	5694	<75.0	<75.0	0	0
107	POND SORTER	1537	<75.0	<75.0	0	0
108	LOG SORTER	512	<75.0	<75.0	0	0
217	WELDER	256	<75.0	<75.0	0	0

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ENVIRONMENTAL PROTECTION AGENCY                         BBN JOB NO.   9635

 TABLE 5-3   PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES
  (Cont'd)
                               EPA CRITERIA

SIC CODE =  242          AVERAGE FOR INDUSTRY         NO DATES SPECIFIED




**************************************************************************

TOTAL NUMBER OF PERSONNEL                                  231700
TOTAL NUMBER OF PERSONNEL WITH LEQ > 75 (MEAN)             208632
TOTAL NUMBER OF PERSONNEL WITH LEQ > 75 (W.C.)             212477
TOTAL NUMBER OF PERSONNEL WITH LEQ > 90 (MEAN)              64588
TOTAL NUMBER OF PERSONNEL WITH LEQ > 90 (W.C.)             133535
LEVEL WEIGHTED POPULATION (MEAN)                          1076540.0
LEVEL WEIGHTED POPULATION (W.C.)                          1625903.0

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TABLE 5-4 PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
168	PLANER SET-UP MAN	3329	104.5	108.1	7.45	12.29
137	CHIPPER OPERATOR	2304	97.9	101.5	3.00	4.94
128	QUADSAW TAIL SAWYER	512	97.0	97.0	2.64	2.64
127	TAIL SAWYER	1793	96.5	102.6	2.46	5.71
167	PLANER OPERATOR	7175	95.1	98.8	2.02	3.36
144	LUMBER DIVERTER	1792	94.2	95.3	1.79	2.38
185	RIPSAW OPERATOR	256	94.0	94.0	1.74	1.74
138	HOG OPERATOR	1536	93.9	96.5	1.71	2.46
213	MILLWRIGHT/PLANER	1792	92.6	95.9	1.44	2.28
133	SLAB BOARD PULLER	512	92.5	93.2	1.41	1.56
186	RIPSAW OFFBEARER	256	92.0	92.0	1.32	1.32
212	MILLWRIGHT/SAWMILL	3843	91.2	91.8	1.17	1.28
173	GRADER/PLANER MILL	13837	91.0	93.2	1.15	1.56
245	OILER	1536	91.0	92.2	1.15	1.36
191	SPECIALTY RESAW OFFB	1280	90.8	95.3	1.11	2.39
190	SPECIALTY RESAW OPER	1024	90.3	97.9	1.05	2.99
101	SAWMILL SUPERVISOR	3328	90.2	90.9	1.03	1.13
233	CARPENTERS	2049	<90.0	90.4	0.94	1.06
140	RESAW OPERATOR	3075	<90.0	91.6	0.92	1.28
104	PLANER SUPERVISOR	2561	<90.0	90.5	0.92	1.07
211	MILLWRIGHT/GENERAL	14095	<90.0	91.2	0.91	1.18
117	DECK SCALER	1024	<90.0	93.4	0.86	1.61
151	GREEN CHAIN PULLER	7430	<90.0	93.7	0.86	1.66
228	ELECTRICIANS	10506	<90.0	<90.0	0.76	0.96
261	CLEAN-UP MAN/REGULAR	2560	<90.0	90.2	0.72	1.03
159	TRANSFER OPERATOR	1280	<90.0	103.1	0.71	6.15
134	EDGER OPERATOR	6407	<90.0	93.6	0.67	3.30
238	PIPE-FITTERS	768	<90.0	<90.0	0.54	0.59
143	UNSCRAMBLE OPERATOR	1280	<90.0	91.7	0.53	1.26
265	LABORER	1792	<90.0	<90.0	0.52	0.67
216	SHOPMAN/GENERAL	256	<90.0	<90.0	0.44	0.51
148	TRIMMER OPERATOR	9479	<90.0	94.2	0.41	1.79
266	HELPER	2561	<90.0	<90.0	0.38	0.63
120	CUT-OFF SAW OPERATOR	512	<90.0	<90.0	0.36	0.52
219	MACHINISTS	4866	<90.0	<90.0	0.25	0.25
196	MOULDER FEEDER	768	<90.0	<90.0	0.13	0.13

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TABLE 5-4　PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES
(Cont'd)

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242　　AVERAGE FOR INDUSTRY　　NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
179	BANDER OPERATOR	2304	<90.0	<90.0	0.11	0.13
161	UNSTACKER-DRY	1793	<90.0	<90.0	0.06	0.92
244	FILERS	6918	<90.0	<90.0	0.06	0.06
262	CLEAN-UP MAN/DOWN TM	2049	<90.0	<90.0	0.02	0.46
114	DEBARKER OPERATOR	4666	<90.0	<90.0	0.02	0.02
182	TALLYMEN	4098	<90.0	<90.0	0.01	0.48
176	DRY CHAIN PULLER	23321	<90.0	<90.0	0.01	0.02
107	POND SORTER	1537	<90.0	<90.0	0.00	0.0
108	LOG SORTER	512	<90.0	<90.0	0.00	0.0
111	LOG CARRIER OPER	512	<90.0	<90.0	0.00	0.0
123	SAWYER	5894	<90.0	<90.0	0.00	0.0
131	GANG SAW OPERATOR	1025	<90.0	<90.0	0.00	0.0
145	GREEN CHAIN OPERATOR	2617	<90.0	<90.0	0.00	0.87
154	STACKER-GREEN	7174	<90.0	90.9	0.00	1.13
155	STICKERMAN-GREEN	4355	<90.0	90.1	0.00	1.02
156	UNIPAC OPERATOR	512	<90.0	<90.0	0.00	0.0
160	KILN OPERATOR	2817	<90.0	<90.0	0.00	0.13
162	UNSTACKER PULLER	2618	<90.0	<90.0	0.00	0.15
163	GRADER/SORTING CHAIN	768	<90.0	91.3	0.00	1.19
181	CHECKERS	1537	<90.0	<90.0	0.00	0.0
197	MOULDER OFFBEARER	768	<90.0	<90.0	0.00	0.0
201	LUMBER CARRIER OPER	5125	<90.0	<90.0	0.00	0.0
202	FORKLIFT OPERATOR	14607	<90.0	<90.0	0.00	0.84
207	RAILCAR LOADER	3331	<90.0	<90.0	0.00	0.0
217	WELDER	256	<90.0	<90.0	0.00	0.0
223	MECHANICS	5894	<90.0	<90.0	0.00	0.0
248	POWERHOUSE OPERATOR	4611	<90.0	<90.0	0.00	0.47

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 TABLE 5-4    PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES
  (Cont'd)
                           THRESHOLD LEVEL         = 90.0 DBA
                           8-HR PERMISSIBLE LEVEL = 90.0 DBA
                           EXCHANGE RATE           = 5 DBA

SIC CODE =  242           AVERAGE FOR INDUSTRY        NO DATES SPECIFIED




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                 TOTAL NUMBER OF PERSONNEL         = 231700
                 TOTAL NUMBER OVEREXPOSED (MEAN) =  57668
                 TOTAL NUMBER OVEREXPOSED (W.C.) =  92526

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Results for the equipment noise impact are listed in Tables 5-5 and 5-6 for individual equipment types specified in the input data (one line for each equipment type). Equipment types having no impact on any personnel are omitted from the tables. A name "BACK.ONLY CONT." in column 2 indicates that equipment was only identified as a contributor to a background level. The contribution of background locations to the equipment impact is also included for each equipment type listed as explained in Section 3. In Tables 5-8 and 5-9 results are given for general equipment classifica tions containing several equipment types as listed in Table 5-7 (one line for each general classification in Tables 5-7, 5-8 and 5-9). Each general classification usually consists of all equipment types with the same generic name. Results for the EPA analysis are contained in Tables 5-5 and 5-8 and results for the OSHA analysis are contained in Tables 5-6 and 5-9.

Referring to Tables 5-5 and 5-6, columns one to six represent the same quantity for both. The first column contains a four-digit equipment code unique to the particular equipment type or background being considered. The second column is a 17-letter description of the equipment generic name. The third column indicates the number of equipment units of this type for which we have sound level measurements. The fourth and fifth columns are the mean and worst case sound levels derived by averaging all measurements for each equipment type. The worst case sound level is derived by adding one standard deviation to the mean. The sixth column shows how many personnel are exposed to this equipment type for all or part of their day.

The seventh and eighth columns in Tables 5-5 and 5-6 are the Priority Index (PI_n) and normalized Priority Index (NPI_n) respectively for equipment type n described by the code in column 1. The values of PI_n corresponding to the EPA analysis are calculated using Equation 3-13 in Section 3 and values corresponding to the OSHA analysis are calculated using Equation 3-20.

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TABLE 5-5 EQUIPMENT NOISE IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1623	HEADRIG	9	83.2	87.9	109114	20631.2	0.099
1702	PLANER	12	112.6	116.8	97094	15827.0	0.076
1741	DRY CHAIN CONVEYR	10	85.2	89.1	25874	11289.3	0.054
1802	FORKLIFT	9	86.6	90.2	28950	11105.9	0.053
1716	PLANER/ENCL	14	92.8	95.4	80707	10526.7	0.050
1670	TRIMMER	11	87.7	95.9	138842	9733.5	0.047
1682	GREEN CHAIN CONVY	15	86.5	91.0	75561	8182.1	0.039
1638	EDGER	8	85.9	94.1	82224	8018.3	0.038
1711	PLANER/ENCL	15	94.2	97.9	92741	7924.0	0.038
1693	KILN CHAIN CONVYR	13	82.9	89.0	46105	7723.4	0.037
1690	KILN CHAIN CONVYR	17	86.4	92.7	34835	7262.4	0.035
1742	DRY CHAIN CONVEYR	10	86.9	89.0	51236	6745.5	0.032
1647	RESAW-LARGE	4	93.0	95.2	59941	5235.3	0.025
1636	EDGER	4	95.5	104.5	109892	5057.0	0.024
1683	GREEN CHAIN CONVY	4	95.3	97.3	35083	4867.8	0.023
1691	KILN CHAIN CONVYR	14	85.4	91.8	31504	3878.3	0.019
1692	KILN CHAIN CONVYR	7	88.4	92.1	27918	3798.1	0.018
1672	TRIMMER	8	92.0	95.5	55582	3772.3	0.018
1831	GANG SAW	2	78.0	79.4	74025	3343.1	0.016
1603	DEBARKER	7	78.3	85.0	6915	3235.4	0.016
1694	KILN CHAIN CONVYR	9	85.4	88.3	33300	2967.5	0.014
1822	QUADSAW	1	90.0	90.0	53526	2876.1	0.014
1796	POWERHOUSE	3	86.3	90.4	4867	2600.9	0.012
1784	CHIPPER	16	103.1	107.0	23301	2600.0	0.012
1794	POWERHOUSE	2	87.5	92.4	4867	1996.6	0.010
1764	RESAW-SPECIALTY	4	96.5	103.1	51493	1459.5	0.007
1695	KILN CHAIN CONVYR	5	86.2	93.0	1536	1401.5	0.007
1788	HOG/ENCL	2	95.0	96.4	38683	1374.4	0.007
1687	KILN	7	83.6	89.6	3585	1324.0	0.006
1627	HEADRIG	3	97.7	104.3	1537	1321.1	0.006

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-5 (Cont'd) EQUIPMENT NOISE IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1752	STACK BANDER	3	83.3	84.9	3073	1270.4	0.006
1815	TRANSFER CARRIER	2	91.0	106.6	3072	1165.1	0.006
1674	TRIMMER	1	95.0	95.0	13318	1164.4	0.006
1762	RESAW-SPEC/ENCL	2	88.0	90.8	38944	814.6	0.004
1731	MOULDER/ENCL	3	81.3	88.0	768	768.0	0.004
1681	GREEN CHAIN CONVY	1	76.0	76.0	47369	752.4	0.004
1639	EDGER	2	92.5	93.2	1024	584.6	0.003
1766	RESAW-SPEC/ENCL	2	90.0	91.4	2048	579.8	0.003
1727	MOULDER/ENCL	2	84.5	89.4	768	559.8	0.003
1768	RESAW-SPECIALTY	3	94.7	97.9	512	512.0	0.002
1824	QUADSAW	1	97.0	97.0	512	512.0	0.002
1612	CUT-OFF SAW	2	85.0	87.8	38427	500.2	0.002
1622	HEADRIG	9	79.1	83.9	6150	499.8	0.002
1669	TRIMMER	12	86.3	95.1	4613	461.8	0.002
1613	CUT-OFF SAW	3	99.3	101.8	1024	470.4	0.002
1637	EDGER	8	83.6	93.2	3588	456.0	0.002
1602	DEBARKER	7	75.4	82.3	3330	436.8	0.002
1654	RESAW-LARGE	1	74.0	74.0	10243	422.1	0.002
1619	CUT-OFF SAW	1	95.0	95.0	38171	372.5	0.002
1790	HOG	2	98.0	103.7	768	369.5	0.002
1617	CUT-OFF SAW	4	75.6	81.9	5635	310.5	0.001
1713	BACK. ONLY CONTR.	0	76.0	78.0	36696	306.8	0.001
1782	CHIPPER/ENCL	3	103.3	109.8	512	301.0	0.001
1646	RESAW-LARGE	4	88.5	92.4	2563	297.3	0.001
1696	KILN CHAIN CONVYR	3	88.0	94.1	256	256.0	0.001
1853	RIPSAW-SPECIALTY	1	92.0	92.0	256	256.0	0.001
1851	RIPSAW-SPECIALTY	1	94.0	94.0	256	256.0	0.001
1783	CHIPPER	9	90.0	93.0	10502	239.4	0.001
1626	HEADRIG	3	97.3	99.4	1537	215.9	0.001
1635	EDGER	4	88.5	95.7	2819	213.3	0.001

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-5
(Cont'd)

EQUIPMENT NOISE IMPACT

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1751	STACK BANDER	3	79.0	82.6	768	206.9	0.001
1734	MOULDER	1	95.0	95.0	256	188.7	0.001
1787	HOG/ENCL	1	91.0	91.0	768	176.3	0.001
1658	RESAW-LARGE	1	74.0	74.0	5890	175.3	0.001
1715	PLANER/ENCL	1	93.0	93.0	1537	160.7	0.001
1710	PLANER/ENCL	4	91.3	96.4	3331	129.7	0.001
1618	CUT-OFF SAW	1	94.0	94.0	256	49.3	0.000
1830	GANG SAW	2	75.5	77.6	1025	44.7	0.000
1726	MOULDER/ENCL	2	76.5	78.6	512	19.5	0.000
1816	TRANSFER CARRIER	1	76.0	76.0	768	3.3	0.000
1513	WHEEL GRINDER	1	79.0	79.0	3587	1.0	0.000

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-6 EQUIPMENT NOISE CONTROL PRIORITY

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1716	PLANER/ENCL	14	92.8	95.4	28947	9662.7	0.168
1711	PLANER/ENCL	15	94.2	97.9	27408	6605.9	0.115
1702	PLANER	12	112.8	116.8	23563	6165.4	0.107
1683	GREEN CHAIN CONVY	4	95.3	97.3	12806	4664.0	0.081
1623	HEADRIG	9	83.2	87.9	44046	4437.9	0.077
1647	RESAW-LARGE	4	93.0	95.2	18695	4379.1	0.076
1636	EDGER	4	95.5	104.5	37388	3939.4	0.068
1784	CHIPPER	16	103.1	107.0	2816	2426.8	0.042
1638	EDGER	8	85.9	94.1	26632	2271.9	0.039
1672	TRIMMER	8	92.0	95.5	9985	2165.6	0.038
1831	GANG SAW	2	78.0	79.4	30474	1469.1	0.025
1627	HEADRIG	3	97.7	104.3	1537	1315.4	0.023
1670	TRIMMER	11	87.7	95.9	31500	932.8	0.016
1822	QUADSAW	1	90.0	90.0	30966	924.2	0.016
1764	RESAW-SPECIALTY	4	96.5	103.1	10503	738.3	0.013
1639	EDGER	2	92.5	93.2	1024	673.0	0.012
1788	HOG/ENCL	2	95.0	96.4	13828	670.4	0.012
1768	RESAW-SPECIALTY	3	94.7	97.9	512	512.0	0.009
1824	QUADSAW	1	97.0	97.0	512	512.0	0.009
1790	HOG	2	98.0	103.7	768	424.7	0.007
1654	RESAW-LARGE	1	74.0	74.0	8195	318.2	0.006
1851	RIPSAW-SPECIALTY	1	94.0	94.0	256	256.0	0.004
1853	RIPSAW-SPECIALTY	1	92.0	92.0	256	256.0	0.004
1787	HOG/ENCL	1	91.0	91.0	768	230.2	0.004
1626	HEADRIG	3	97.3	99.4	1537	221.6	0.004
1782	CHIPPER/ENCL	3	103.3	109.8	512	179.9	0.003

TABLE 5-6 (Cont'd) EQUIPMENT NOISE CONTROL PRIORITY

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1710	PLANER/ENCL	4	91.3	96.4	3331	167.8	0.003
1658	RESAW-LARGE	1	74.0	74.0	5890	164.6	0.003
1715	PLANER/ENCL	1	93.0	93.0	1537	157.9	0.003
1612	CUT-OFF SAW	2	85.0	87.8	13060	107.8	0.002
1682	GREEN CHAIN CONVY	15	86.5	91.0	7937	75.8	0.001
1713	BACK. ONLY CONTR.	0	76.0	78.0	9735	59.0	0.001
1613	CUT-OFF SAW	3	99.3	101.8	512	54.1	0.001
1619	CUT-OFF SAW	1	95.0	95.0	13060	53.9	0.001
1762	RESAW-SPEC/ENCL	2	88.0	90.8	9735	29.5	0.001
1742	DRY CHAIN CONVEYR	10	86.9	69.0	7937	21.6	0.000
1681	GREEN CHAIN CONVY	1	76.0	76.0	7937	10.8	0.000

TABLE 5-7

LIST OF GENERALIZED EQUIPMENT CODES

CODE	BEGIN	END	GENERAL DESCRIPTION
1600	1600	1609	DEBARKER
1610	1610	1619	CUT-OFF
1620	1620	1628	HEADRIG
1629	1629	1643	EDGER
1644	1644	1663	RESAW/LARGE
1664	1664	1678	TRIMMER
1679	1679	1684	GREEN CHAIN
1685	1685	1687	KILN
1688	1688	1698	KILN CHAIN
1699	1699	1723	PLANER
1724	1724	1738	MOULDER
1739	1739	1746	DRY CHAIN
1747	1747	1748	RAIL CAR LOAD
1749	1749	1758	STACK BANDER
1759	1759	1775	RESAW/SPECIALTY
1776	1776	1778	CONVEYOR/GEN
1779	1779	1784	CHIPPER
1785	1785	1791	HOG
1792	1792	1797	POWERHOUSE
1798	1798	1799	SAWMILL OFFICE
1800	1800	1807	FORKLIFT
1808	1808	1809	LOG CARRIER
1810	1810	1812	LUMBER CARRIER
1813	1813	1818	TRANSFER CARRIER
1819	1819	1827	QUADSAW
1828	1828	1847	GANG SAW
1848	1848	1867	RIP SAW/SPECIALTY
1868	1868	1869	STORAGE
1870	1870	1871	BASEMENT
1872	1872	1873	MACHINE SHOP
1874	1874	1875	CARPENTRY SHOP
1876	1876	1877	ELECTRIC SHOP
1878	1878	1879	PIPE SHOP
1880	1880	1881	FILEROOM
1882	1882	1883	MECHANIC SHOP/GARAGE

ENVIRONMENTAL PROTECTION AGENCY

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TABLE 5-8 EQUIPMENT NOISE IMPACT AVERAGES

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO. OF PERS.	PRIORITY INDEX	NORM. P.I.
1699	PLANER	46	98.3	102.0	312306	34874.8	0.167
1688	KILN CHAIN	68	85.7	91.4	175454	27287.2	0.131
1620	HEADRIG	24	85.2	90.0	118338	22668.0	0.109
1739	DRY CHAIN	20	86.0	89.2	77110	18034.7	0.086
1800	FORKLIFT	9	86.6	90.2	34587	16384.6	0.079
1664	TRIMMER	33	88.5	96.1	212355	15152.1	0.073
1629	EDGER	26	87.6	96.1	199547	14329.2	0.069
1679	GREEN CHAIN	20	87.7	91.9	158033	13802.4	0.066
1644	RESAW/LARGE	14	86.2	89.4	78637	6130.0	0.029
1810	LUMBER CARRIER	6	85.4	87.8	17677	5205.4	0.025
1792	POWERHOUSE	5	86.8	91.2	9734	4597.4	0.022
1600	DEBARKER	17	76.0	82.8	21516	4138.6	0.020
1819	QUADSAW	3	94.0	94.0	54038	3388.1	0.016
1828	GANG SAW	4	76.8	78.6	75050	3387.8	0.016
1759	RESAW/SPECIALTY	15	94.3	98.6	92997	3365.9	0.016
1779	CHIPPER	30	98.9	102.7	34315	3140.4	0.015
1776	CONVEYOR/GEN	5	87.8	90.9	93488	2737.5	0.013
1785	HOG	8	95.1	100.5	40219	1920.2	0.009
1610	CUT-OFF	16	84.3	93.2	83513	1702.8	0.008
1724	MOULDER	10	86.8	91.7	2304	1536.0	0.007
1749	STACK BANDER	6	81.2	83.9	3841	1477.3	0.007
1685	KILN	7	83.6	89.6	3585	1324.0	0.006
1813	TRANSFER CARRIER	3	86.0	101.6	3840	1168.4	0.006
1846	RIP SAW/SPECIALTY	4	88.0	88.0	512	512.0	0.002
1808	LOG CARRIER	1	90.0	90.0	256	256.0	0.001
1798	SAWMILL OFFICE	1	70.0	70.0	768	4.8	0.000

TABLE 5-9 EQUIPMENT NOISE CONTROL PRIORITY AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1699	PLANER	46	98.3	102.0	94521	22818.7	0.396
1629	EDGER	26	87.6	96.1	67863	6884.2	0.119
1620	HEADRIG	24	85.2	90.0	47120	5974.9	0.104
1644	RESAW/LARGE	14	86.2	89.4	35343	4861.9	0.084
1679	GREEN CHAIN	20	87.7	91.9	28680	4750.6	0.082
1664	TRIMMER	33	88.5	96.1	41741	3096.4	0.054
1779	CHIPPER	30	98.9	102.7	5632	2606.7	0.045
1828	GANG SAW	4	76.8	78.6	30474	1469.1	0.025
1819	QUADSAW	3	94.0	94.0	31498	1436.2	0.025
1785	HOG	8	95.1	100.5	15364	1325.4	0.023
1759	RESAW/SPECIALTY	15	94.3	98.6	20750	1279.8	0.022
1848	RIP SAW/SPECIALTY	4	88.0	88.0	512	512.0	0.009
1776	CONVEYOR/GEN	5	87.8	90.9	30728	378.6	0.007
1610	CUT-OFF	16	84.3	93.2	26632	215.8	0.004
1739	DRY CHAIN	20	86.0	89.2	7937	21.6	0.000

The results shown in Tables 5-8 and 5-9 are similar to those in Tables 5-5 and 5-6, except that each line represents a general equipment classification which includes the equipment types listed in Table 5-7. Thus each result is an average over several equipment types in the same general classification. Note that for some categories the number of personnel affected by the general equipment type can sometimes exceed the total industry population. This is because more than one equipment type from the same general classification affects the same portions of the population, resulting in some personnel being counted more than once.

As a demonstration of the capability of the computer model, an example showing the effect on personnel noise exposure impact, of specified amounts of noise control for some given equipment types, is now discussed.

A list containing equipment types to be treated and the amount of noise reduction to be used for each type is included in the computer model as input data and is reproduced in Table 5-10.

The effect of the noise reductions on the equipment average noise levels is included in Tables 5-11 and 5-12; Table 5-11 for individual equipment or background types and Table 5-12 for general equipment classifications, each of which includes several equipment types. The background noise levels are not averaged with the equipment noise levels for the generalized equipment categories. The first column in each table contains a four-digit equipment code and the second column contains a 17-letter general description of the equipment or background type or classification, one line of table for each equipment type in Table 5-11 and one line for each general equipment classification in Table 5-12. The third column indicates the number of noise measurements we have for the particular equipment type or classification. Columns four, five and six are, respectively, the mean noise

TABLE 5-10

INPUT NOISE REDUCTION DATA

EACH LINE SHOWS THE NOISE REDUCTION
SPECIFICATIONS FOR A RANGE OF EQUIPMENT CODES

CODE FOR BEGINNING OF RANGE	CODE FOR END OF RANGE	NOISE REDUCTION
1699	1723	10
1629	1643	7
1620	1628	5
1644	1663	5
1679	1684	5
1664	1678	7
1779	1784	10

TABLE 5-11 EFFECT OF EQUIPMENT NOISE CONTROL

BACKGROUND AND EQUIPMENT NOISE DATA AVERAGES (LEQ)

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	MEAN LEQ (DBA) AFTER	NOISE RED. (DBA)
1702	PLANER	12	112.8	102.8	10.0
1735	MOULDER	2	103.5	103.5	0.0
1782	CHIPPER/ENCL	3	103.3	93.3	10.0
1784	CHIPPER	15	103.1	93.1	10.0
1763	RESAW-SPECIALTY	2	100.0	100.0	0.0
1613	CUT-OFF SAW	3	99.3	99.3	0.0
1781	CHIPPER/ENCL	2	98.0	88.0	10.0
1790	HOG	2	98.0	98.0	0.0
1627	HEADRIG	3	97.7	92.7	5.0
1626	HEADRIG	3	97.3	92.3	5.0
1824	QUADSAW	1	97.0	97.0	0.0
1764	RESAW-SPECIALTY	4	96.5	96.5	0.0
1780	BACK/CHIPPER	4	96.3	87.7	8.6
1645	BACK/RESAW	5	95.8	91.8	4.0
1636	EDGER	4	95.5	88.5	7.0
1683	GREEN CHAIN CONVY	4	95.3	90.3	5.0
1619	CUT-OFF SAW	1	95.0	95.0	0.0
1649	RESAW-LARGE	1	95.0	90.0	5.0
1674	TRIMMER	1	95.0	88.0	7.0
1734	MOULDER	1	95.0	95.0	0.0
1788	HOG/ENCL	2	95.0	95.0	0.0
1823	QUADSAW	1	95.0	95.0	0.0
1829	BACK/GANG SAW	2	95.0	94.4	0.6
1768	RESAW-SPECIALTY	3	94.7	94.7	0.0
1789	HOG	3	94.7	94.7	0.0
1767	RESAW-SPECIALTY	2	94.5	94.5	0.0
1711	PLANER/ENCL	15	94.2	84.2	10.0
1618	CUT-OFF SAW	1	94.0	94.0	0.0
1820	BACK/QUAD SAW	1	94.0	93.4	0.6
1851	RIPSAW-SPECIALTY	1	94.0	94.0	0.0
1630	BACK/EDGER	9	93.6	87.8	5.8
1621	BACK/HEADRIG	8	93.5	89.2	4.3
1647	RESAW-LARGE	4	93.0	88.0	5.0
1715	PLANER/ENCL	1	93.0	83.0	10.0
1716	PLANER/ENCL	14	92.8	82.8	10.0
1700	BACK/PLANER	9	92.6	83.8	8.8
1639	EDGER	2	92.5	85.5	7.0
1672	TRIMMER	6	92.0	85.0	7.0

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TABLE 5-11 EFFECT OF EQUIPMENT NOISE CONTROL
(Cont'd)

BACKGROUND AND EQUIPMENT NOISE DATA AVERAGES (LEQ)

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	AFTER	NOISE RED. (DBA)
1725	BACK/MOULDER	1	92.0	92.0	0.0
1853	RIPSAW-SPECIALTY	1	92.0	92.0	0.0
1710	PLANER/ENCL	4	91.3	81.3	10.0
1671	TRIMMER	1	91.0	84.0	7.0
1760	BACK/SPEC RESAW	3	91.0	90.1	0.9
1787	HOG/ENCL	1	91.0	91.0	0.0
1815	TRANSFER CARRIER	2	91.0	91.0	0.0
1665	BACK/TRIMMER	13	90.6	84.2	6.4
1648	RESAW-LARGE	1	90.0	85.0	5.0
1766	RESAW-SPEC/ENCL	2	90.0	90.0	0.0
1783	CHIPPER	9	90.0	80.0	10.0
1822	QUADSAW	1	90.0	90.0	0.0
1871	BACK/BASEMENT	11	89.1	85.1	4.0
1635	EDGER	4	88.5	81.5	7.0
1646	RESAW-LARGE	4	88.5	83.5	5.0
1692	KILN CHAIN CONVYR	7	88.4	88.4	0.0
1696	KILN CHAIN CONVYR	3	88.0	88.0	0.0
1762	RESAW-SPEC/ENCL	2	88.0	88.0	0.0
1670	TRIMMER	11	87.7	80.7	7.0
1601	BACK/DEBARKER	4	87.5	87.2	0.3
1794	POWERHOUSE	2	87.5	87.5	0.0
1742	DRY CHAIN CONVEYR	10	86.9	86.9	0.0
1802	FORKLIFT	9	86.6	86.6	0.0
1682	GREEN CHAIN CONVY	15	86.5	81.5	5.0
1690	KILN CHAIN CONVYR	17	86.4	86.4	0.0
1796	POWERHOUSE	3	86.3	86.3	0.0
1669	TRIMMER	12	86.3	79.3	7.0
1695	KILN CHAIN CONVYR	5	86.2	86.2	0.0
1638	EDGER	8	85.9	78.9	7.0
1694	KILN CHAIN CONVYR	9	85.4	85.4	0.0
1691	KILN CHAIN CONVYR	14	85.4	85.4	0.0
1741	DRY CHAIN CONVEYR	10	85.2	85.2	0.0
1612	CUT-OFF SAW	2	85.0	85.0	0.0
1793	BACK/POWERHOUSE	3	84.7	84.7	0.0
1727	MOULDER/ENCL	2	84.5	84.5	0.0
1814	BACK/TRANSFER RM	1	84.0	83.0	1.0
1849	BACK/SPEC RIPSAW	1	84.0	84.0	0.0
1850	RIPSAW-SPECIALTY	1	84.0	84.0	0.0

TABLE 5-11 EFFECT OF EQUIPMENT NOISE CONTROL
(Cont'd)

BACKGROUND AND EQUIPMENT NOISE DATA AVERAGES (LEQ)

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	MEAN LEQ (DBA) AFTER	NOISE RED. (DBA)
1686	BACK/KILN&CNTL RM	6	83.7	83.6	0.1
1689	BACK/KILN CHAIN	6	83.7	82.9	0.8
1637	EDGER	6	83.6	76.6	7.0
1687	KILN	7	83.6	83.6	0.0
1752	STACK BANDER	3	83.3	83.3	0.0
1623	HEADRIG	9	83.2	78.2	5.0
1680	BACK/GREEN CHAIN	7	83.1	78.9	4.3
1799	BACK/OFFICE/SAWML	1	83.0	78.1	4.9
1693	KILN CHAIN CONVYR	13	82.9	82.9	0.0
1740	BACK/DRY CHAIN	6	82.8	81.0	1.8
1852	RIPSAW-SPECIALTY	1	82.0	82.0	0.0
1731	MOULDER/ENCL	3	81.3	81.3	0.0
1881	BACK/FILEROOM	12	81.2	76.5	4.7
1622	HEADRIG	9	79.1	74.1	5.0
1513	WHEEL GRINDER	1	79.0	79.0	0.0
1751	STACK BANDER	3	79.0	79.0	0.0
1603	DEBARKER	7	78.3	78.3	0.0
1831	GANG SAW	2	78.0	78.0	0.0
1616	CUT-OFF SAW	5	77.8	77.8	0.0
1726	MOULDER/ENCL	2	76.5	76.5	0.0
1713	BACK. ONLY CONTR.	0	76.0	67.2	8.8
1681	GREEN CHAIN CONVY	1	76.0	71.0	5.0
1816	TRANSFER CARRIER	1	76.0	76.0	0.0
1617	CUT-OFF SAW	4	75.8	75.8	0.0
1830	GANG SAW	2	75.5	75.5	0.0
1602	DEBARKER	7	75.4	75.4	0.0
1877	BACK/ELECT SHOP	1	75.0	75.0	0.0
1879	BACK/PIPE SHOP	2	75.0	74.6	0.4
1654	RESAW-LARGE	1	74.0	69.0	5.0
1655	RESAW-LARGE	1	74.0	69.0	5.0
1658	RESAW-LARGE	1	74.0	69.0	5.0
1659	RESAW-LARGE	1	74.0	69.0	5.0
1607	DEBARKER	1	72.0	72.0	0.0
1873	BACK/MACHINE SHOP	7	71.9	71.3	0.5
1883	BACK/MECHANIC SHP	2	67.5	67.5	0.0
1606	DEBARKER	1	65.0	65.0	0.0
1869	BACK/STORAGE	1	65.0	65.0	0.0
1875	BACK/CARPNTR SHOP	1	65.0	65.0	0.0

TABLE 5-12 EFFECT OF EQUIPMENT NOISE CONTROL

EQUIPMENT NOISE DATA AVERAGES (LEQ) GENERALIZED

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	MEAN LEQ (DBA) AFTER	NOISE RED. (DBA)
1779	CHIPPER	30	96.9	88.9	10.0
1699	PLANER	45	96.3	86.3	10.0
1785	HOG	8	95.1	95.1	0.0
1759	RESAW/SPECIALTY	15	94.3	94.3	0.0
1819	QUADSAW	3	94.0	94.0	0.0
1808	LOG CARRIER	1	90.0	90.0	0.0
1664	TRIMMER	35	88.5	81.5	7.0
1848	RIP SAW/SPECIALTY	4	88.0	88.0	0.0
1776	CONVEYOR/GEN	5	87.6	87.6	0.0
1679	GREEN CHAIN	20	87.7	82.7	5.0
1629	EDGER	26	87.6	80.6	7.0
1724	MOULDER	10	86.8	86.8	0.0
1792	POWERHOUSE	5	86.8	86.8	0.0
1800	FORKLIFT	9	86.6	86.6	0.0
1644	RESAW/LARGE	14	86.2	81.2	5.0
1739	DRY CHAIN	20	86.0	86.0	0.0
1813	TRANSFER CARRIER	3	86.0	86.0	0.0
1688	KILN CHAIN	66	85.7	85.7	0.0
1810	LUMBER CARRIER	5	85.4	85.4	0.0
1620	HEADRIG	24	85.2	80.2	5.0
1610	CUT-OFF	15	84.3	84.3	0.0
1685	KILN	7	83.6	83.6	0.0
1749	STACK BANDER	6	81.2	81.2	0.0
1828	GANG SAW	4	76.8	76.8	0.0
1600	DEBARKER	17	76.0	76.0	0.0
1747	RAIL CAR LOAD	3	72.7	72.7	0.0
1798	SAWMILL OFFICE	1	70.0	70.0	0.0

TABLE 5-13
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	--- LEVEL WEIGHTED POPULATION --- BEFORE MEAN	W.C.	AFTER MEAN	W.C.	CHANGE MEAN	W.C.
173	GRADER/PLANER MILL	13837	92323	121382	22236	38896	70087	82486
211	MILLWRIGHT/GENERAL	14095	86567	111593	40789	65241	45778	46352
168	PLANER SET-UP MAN	3329	79853	100769	37173	51646	42680	49123
167	PLANER OPERATOR	7175	78610	111853	22563	41598	56047	70255
176	DRY CHAIN PULLER	23321	62407	100916	61360	99641	1047	1275
228	ELECTRICIANS	10506	59679	75452	26780	40266	32899	35186
148	TRIMMER OPERATOR	9479	49056	93561	13669	39538	35387	54023
151	GREEN CHAIN PULLER	7430	43544	61372	21605	33675	21939	27697
202	FORKLIFT OPERATOR	14607	41980	75054	41317	74603	663	451
134	EDGER OPERATOR	6407	36306	86772	11856	43623	24450	43149
137	CHIPPER OPERATOR	2304	33812	45672	12917	19686	20895	259[illegible]
212	MILLWRIGHT/SAWMILL	3843	28839	31331	15070	16192	13769	15[illegible]
101	SAWMILL SUPERVISOR	3328	23122	25305	13082	16613	10040	8692
154	STACKER-GREEN	7174	20841	50144	19714	49818	1127	326
127	TAIL SAWYER	1793	20058	32880	11983	22138	8075	10742
213	MILLWRIGHT/PLANER	1792	20005	25783	7586	11416	12419	14367
140	RESAW OPERATOR	3075	18887	23680	9488	12963	9399	10717
144	LUMBER DIVERTER	1792	17226	21006	9514	12177	7712	8829
261	CLEAN-UP MAN/REGULAR	2560	16617	20817	7124	9622	9493	11195
138	HOG OPERATOR	1536	15862	20126	12745	17505	3117	2621
104	PLANER SUPERVISOR	2561	15828	18367	6293	8221	9535	10146
248	POWERHOUSE OPERATOR	4611	14566	24367	14565	24367	1	0
233	CARPENTERS	2049	13473	15146	7489	9607	5984	5539
201	LUMBER CARRIER OPER	5125	11757	18804	11757	18804	0	0
245	OILER	1536	11596	13362	7664	11147	3932	2215
123	SAWYER	5894	11210	21827	4669	9880	6541	11947
155	STICKERMAN-GREEN	4355	10955	27729	10533	27574	422	155
191	SPECIALTY RESAW OFFB	1280	10304	14285	10076	14212	228	73
266	HELPER	2561	8843	13807	6946	12494	1897	1313
219	MACHINISTS	4868	8541	8716	5402	5511	3139	3205
145	GREEN CHAIN OPERATOR	2817	8178	15571	2785	7421	5393	8150
161	UNSTACKER-DRY	1793	8031	11610	7486	12133	545	-523
244	FILERS	6918	7790	17485	1882	6011	5908	11474
190	SPECIALTY RESAW OPER	1024	7592	12396	7364	12323	228	73
182	TALLYMEN	4098	6891	16479	6309	16558	582	-79
265	LABORER	1792	6779	8739	3956	6257	2823	2482
117	DECK SCALER	1024	6665	8853	5119	7483	1546	1[illegible]
159	TRANSFER OPERATOR	1280	6580	27777	6527	27773	53	4

TABLE 5-13 (Cont'd)
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

EPA CRITERIA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	--- LEVEL WEIGHTED POPULATION --- BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
128	QUADSAW TAIL SAWYER	512	6202	6202	6202	6202	0	0
143	UNSCRAMBLE OPERATOR	1280	5893	9276	2315	4525	3578	4751
162	UNSTACKER PULLER	2818	5523	13749	5337	13629	186	120
179	BANDER OPERATOR	2304	4117	5203	2680	3704	1437	1499
262	CLEAN-UP MAN/DOWN TM	2049	4065	6113	3648	5595	417	518
133	SLAB BOARD PULLER	512	3924	4248	1412	1609	2512	2639
238	PIPE-FITTERS	768	3918	4247	2433	2947	1485	1300
120	CUT-OFF SAW OPERATOR	512	3109	3965	3109	3965	0	0
663	GRADER/ ORTING CHAIN	768	30 0	521	606	4H37	4N4	97N
160	KILN OPERATOR	2817	2609	6747	2499	6705	110	42
181	CHECKERS	1537	2359	4277	1404	3871	955	406
185	RIPSAW OPERATOR	256	2313	2313	2313	2313	0	0
196	MOULDER FEEDER	768	2206	3664	2286	3664	0	0
186	RIPSAW OFFBEARER	256	1851	1851	1851	1851	0	0
114	DEBARKER OPERATOR	4866	1762	8602	1762	8602	0	0
156	UNIPAC OPERATOR	512	1397	2274	1397	2274	0	0
216	SHOPMAN/GENERAL	256	1030	1234	358	583	672	651
111	LOG CARRIER OPER	512	921	921	921	921	0	0
197	MOULDER OFFBEARER	768	771	3244	771	3244	0	0
131	GANG SAW OPERATOR	1025	208	456	208	456	0	0
207	RAILCAR LOADER	3331	0	1318	0	1318	0	0
223	MECHANICS	5894	0	0	0	0	0	0
107	POND SORTER	1537	0	0	0	0	0	0
108	LOG SORTER	512	0	0	0	0	0	0
217	WELDER	256	0	0	0	0	0	0

level (L_{eq} dBA) before noise control, the mean noise level after noise control and the difference between the two. Note that background noise levels are not reduced by the same amount as the equipment types which dominate them. This is because more than one equipment type contributes to each background level.

The effect of the specified noise reductions on the personnel noise exposure impact is shown in Table 5-13 for EPA criteria and Table 5-14 for OSHA criteria. Only results corresponding to Tables 5-3 and 5-4 and representing personnel categories subcategories with five-digit codes are not shown to avoid unnecessary detail. The effect of the specified equipment noise reductions on the equivalent eight-hour sound levels ($L_{eq}(8)$) are shown in Tables 5-15 and 5-16. In Table 5-15 $L_{eq}(8)$ is calculated for each personnel category using EPA criteria and the results in Table 5-16 are calculated using OSHA criteria. Again results for personnel subcategories (with 5-digit codes) which make up the personnel categories shown in Tables 5-15 and 5-16 are not shown separately here, but they are produced by the computer model. A summary of the results listed in Tables 5-13 to 5-16 appears in Table 5-17 for EPA results and 5-18 for OSHA results.

The equipment noise impact following the implementation of the specified noise reductions is shown in Table 5-19 for EPA criteria results and Table 5-20 for OSHA criteria results. In Tables 5-19 and 5-20 only results for the general equipment classifications are presented. The results for the individual equipment types are produced by the computer model but are not included here.

TABLE 5-14
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	DAILY NOISE DOSE BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
168	PLANER SET-UP MAN	3329	7.45	12.29	1.66	2.87	5.80	9.43
137	CHIPPER OPERATOR	2304	3.00	4.94	0.62	1.10	2.38	3.84
128	QUADSAW TAIL SAWYER	512	2.64	2.64	2.64	2.64	0.0	0.0
127	TAIL SAWYER	1793	2.46	5.71	1.23	2.85	1.23	2.85
167	PLANER OPERATOR	7175	2.02	3.38	0.08	0.24	1.94	3.14
144	LUMBER DIVERTER	1792	1.79	2.38	0.78	1.08	1.01	1.31
185	RIPSAW OPERATOR	256	1.74	1.74	1.74	1.74	0.0	0.0
138	HOG OPERATOR	1536	1.71	2.46	1.24	1.92	0.48	0.54
213	MILLWRIGHT/PLANER	1792	1.44	2.28	0.27	0.46	1.17	1.82
133	SLAB BOARD PULLER	512	1.41	1.56	0.00	0.0	1.41	1.56
186	RIPSAW OFFBEARER	256	1.32	1.32	1.32	1.32	0.0	0.0
212	MILLWRIGHT/SAWMILL	3843	1.17	1.28	0.19	0.23	0.99	1.05
173	GRADER/PLANER MILL	13837	1.15	1.56	0.00	0.03	1.15	1.53
245	OILER	1536	1.15	1.36	0.44	0.78	0.72	0.58
191	SPECIALTY RESAW OFFB	1280	1.11	2.39	1.01	2.29	0.10	0.10
190	SPECIALTY RESAW OPER	1024	1.05	2.99	0.92	2.87	0.12	0.12
101	SAWMILL SUPERVISOR	3328	1.03	1.13	0.22	0.44	0.81	0.69
233	CARPENTERS	2049	0.94	1.06	0.18	0.36	0.76	0.70
140	RESAW OPERATOR	3075	0.92	1.28	0.00	0.64	0.92	0.64
104	PLANER SUPERVISOR	2561	0.92	1.07	0.14	0.17	0.78	0.90
211	MILLWRIGHT/GENERAL	14095	0.91	1.18	0.12	0.50	0.79	0.69
117	DECK SCALER	1024	0.86	1.61	0.09	0.81	0.77	0.80
151	GREEN CHAIN PULLER	7430	0.86	1.66	0.43	0.57	0.43	1.09
228	ELECTRICIANS	10506	0.76	0.96	0.06	0.32	0.70	0.64
261	CLEAN-UP MAN/REGULAR	2560	0.72	1.03	0.11	0.23	0.61	0.81
159	TRANSFER OPERATOR	1280	0.71	6.15	0.71	6.15	0.0	0.0
134	EDGER OPERATOR	6407	0.67	3.30	0.00	0.94	0.67	2.36
238	PIPE-FITTERS	768	0.54	0.59	0.16	0.31	0.38	0.28
143	UNSCRAMBLE OPERATOR	1280	0.53	1.26	0.00	0.0	0.53	1.26
265	LABORER	1792	0.52	0.67	0.14	0.26	0.38	0.41
216	SHOPMAN/GENERAL	256	0.44	0.51	0.00	0.15	0.44	0.36
148	TRIMMER OPERATOR	9479	0.41	1.79	0.00	0.02	0.41	1.77
266	HELPER	2561	0.38	0.83	0.11	0.55	0.27	0.28
120	CUT-OFF SAW OPERATOR	512	0.36	0.52	0.36	0.52	0.0	0.0

TABLE 5-14 (Cont'd)
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	DAILY NOISE DOSE BEFORE MEAN	W.C.	AFTER MEAN	W.C.	CHANGE MEAN	W.C.
219	MACHINISTS	4868	0.25	0.25	0.06	0.08	0.17	0.17
196	MOULDER FEEDER	768	0.13	0.13	0.13	0.13	0.0	0.0
179	BANDER OPERATOR	2304	0.11	0.13	0.00	0.0	0.11	0.13
161	UNSTACKER-DRY	1793	0.06	0.92	0.00	1.16	0.06	-0.24
244	FILERS	6918	0.06	0.06	0.01	0.01	0.05	0.05
262	CLEAN-UP MAN/DOWN TM	2049	0.02	0.46	0.00	0.45	0.02	0.01
114	DEBARKER OPERATOR	4866	0.02	0.02	0.02	0.02	0.0	0.0
182	TALLYMEN	4098	0.01	0.48	0.00	0.53	0.01	-0.05
176	DRY CHAIN PULLER	23321	0.01	0.02	0.00	0.0	0.01	0.0[illegible]
107	POND SORTER	1537	0.00	0.0	0.00	0.0	0.0	0.0
108	LOG SORTER	512	0.00	0.0	0.00	0.0	0.0	0.0
111	LOG CARRIER OPER	512	0.00	0.0	0.00	0.0	0.0	0.0
123	SAWYER	5894	0.00	0.0	0.00	0.0	0.0	0.0
131	GANG SAW OPERATOR	1025	0.00	0.0	0.00	0.0	0.0	0.0
145	GREEN CHAIN OPERATOR	2817	0.00	0.87	0.00	0.0	0.0	0.87
154	STACKER-GREEN	7174	0.00	1.13	0.00	1.13	0.0	0.0
155	STICKERMAN-GREEN	4355	0.00	1.02	0.00	1.02	0.0	0.0
156	UNIPAC OPERATOR	512	0.00	0.0	0.00	0.0	0.0	0.0
160	KILN OPERATOR	2817	0.00	0.13	0.00	0.13	0.0	0.0
162	UNSTACKER PULLER	2818	0.00	0.15	0.00	0.15	0.0	0.0
163	GRADER/SORTING CHAIN	768	0.00	1.19	0.00	0.89	0.0	0.30
181	CHECKERS	1537	0.00	0.0	0.00	0.0	0.0	0.0
197	MOULDER OFFBEARER	768	0.00	0.0	0.00	0.0	0.0	0.0
201	LUMBER CARRIER OPER	5125	0.00	0.0	0.00	0.0	0.0	0.0
202	FORKLIFT OPERATOR	14607	0.00	0.84	0.00	0.84	0.0	0.0
207	RAILCAR LOADER	3331	0.00	0.0	0.00	0.0	0.0	0.0
217	WELDER	256	0.00	0.0	0.00	0.0	0.0	0.0
223	MECHANICS	5894	0.00	0.0	0.00	0.0	0.0	0.0
248	POWERHOUSE OPERATOR	4611	0.00	0.47	0.00	0.47	0.0	0.0

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

EPA CRITERIA

TABLE 5-15
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
168	PLANER SET-UP MAN	3329	105.7	109.5	95.7	99.5	10.0	10.0
137	CHIPPER OPERATOR	2304	99.1	103.1	89.9	93.4	9.2	9.7
128	QUADSAW TAIL SAWYER	512	97.0	97.0	97.0	97.0	0.0	0.0
167	PLANER OPERATOR	7175	95.7	99.6	85.8	89.7	9.9	10.0
127	TAIL SAWYER	1793	95.5	101.5	90.5	96.5	5.0	5.0
138	HOG OPERATOR	1536	95.2	97.6	93.1	96.1	2.0	1.5
213	MILLWRIGHT/PLANER	1792	94.9	97.5	86.8	89.7	8.1	7.9
144	LUMBER DIVERTER	1792	94.6	96.5	89.6	91.5	5.0	5.2
185	RIPSAW OPERATOR	256	94.0	94.0	94.0	94.0	0.0	0.0
191	SPECIALTY RESAW OFFB	1280	92.8	95.8	92.6	95.7	0.2	0.0
133	SLAB BOARD PULLER	512	92.5	93.2	85.5	86.2	7.0	7.0
212	MILLWRIGHT/SAWMILL	3843	92.3	93.0	87.4	87.8	4.9	5.2
245	OILER	1536	92.3	93.5	88.8	91.6	3.4	1.9
186	RIPSAW OFFBEARER	256	92.0	92.0	92.0	92.0	0.0	0.0
190	SPECIALTY RESAW OPER	1024	91.8	96.3	91.5	96.2	0.2	0.1
101	SAWMILL SUPERVISOR	3328	91.6	92.4	87.3	88.9	4.2	3.5
233	CARPENTERS	2049	91.1	92.1	86.9	88.5	4.2	3.6
173	GRADER/PLANER MILL	13837	91.0	93.6	83.0	85.4	8.0	8.1
117	DECK SCALER	1024	90.8	93.6	89.0	92.1	1.8	1.5
261	CLEAN-UP MAN/REGULAR	2560	90.7	92.5	85.2	86.9	5.5	5.6
104	PLANER SUPERVISOR	2561	90.6	91.9	84.4	86.1	6.3	5.8
211	MILLWRIGHT/GENERAL	14095	90.6	92.7	85.4	88.3	5.2	4.5
120	CUT-OFF SAW OPERATOR	512	90.6	92.6	90.6	92.6	0.0	0.0
228	ELECTRICIANS	10506	90.0	91.9	84.9	87.3	5.1	4.6
134	EDGER OPERATOR	6407	89.4	97.7	82.4	90.7	7.0	7.0
159	TRANSFER OPERATOR	1280	89.3	104.4	89.3	104.4	0.1	0.0
238	PIPE-FITTERS	768	89.3	89.9	86.1	87.3	3.2	2.5
148	TRIMMER OPERATOR	9479	89.2	94.8	82.3	87.9	7.0	7.0
151	GREEN CHAIN PULLER	7430	89.2	92.3	84.3	87.3	5.0	5.0
140	RESAW OPERATOR	3075	89.1	90.9	84.1	85.9	5.0	5.0
161	UNSTACKER-DRY	1793	88.3	91.0	87.9	91.4	0.5	0.0
143	UNSCRAMBLE OPERATOR	1280	88.2	91.6	83.3	86.8	4.9	4.8
216	SHOPMAN/GENERAL	256	87.7	88.9	82.5	84.5	5.2	4.3
163	GRADER/SORTING CHAIN	768	87.6	91.4	86.2	89.3	1.4	2.1
248	POWERHOUSE OPERATOR	4611	86.2	89.5	86.2	89.5	0.0	0.0
154	STACKER-GREEN	7174	85.8	91.7	85.4	91.6	0.3	0.1
145	GREEN CHAIN OPERATOR	2817	85.7	89.8	81.2	85.2	4.5	4.6
202	FORKLIFT OPERATOR	14607	85.7	89.3	85.6	89.3	0.1	0.0

TABLE 5-15 (Cont'd)
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL BEFORE MEAN	SOUND LEVEL BEFORE W.C.	SOUND LEVEL AFTER MEAN	SOUND LEVEL AFTER W.C.	SOUND LEVEL CHANGE MEAN	SOUND LEVEL CHANGE W.C.
196	MOULDER FEEDER	768	85.6	88.8	85.6	88.8	0.0	0.0
156	UNIPAC OPERATOR	512	85.4	88.3	85.4	88.3	0.0	0.0
176	DRY CHAIN PULLER	23321	85.3	88.1	85.2	88.0	0.1	0.1
155	STICKERMAN-GREEN	4355	85.0	90.9	84.8	90.9	0.2	0.0
201	LUMBER CARRIER OPER	5125	84.5	87.1	84.5	87.1	0.0	0.0
266	HELPER	2561	84.4	87.5	83.5	86.9	0.9	0.5
162	UNSTACKER PULLER	2818	83.7	89.0	83.6	88.9	0.1	0.1
123	SAWYER	5894	83.5	87.2	79.3	82.9	4.2	4.2
181	CHECKERS	1537	82.8	85.5	81.0	85.0	1.8	0.5
265	LABORER	1792	82.1	83.6	79.4	81.5	2.7	2.0
197	MOULDER OFFBEARER	768	81.3	88.0	81.3	88.0	0.0	0.0
179	BANDER OPERATOR	2304	79.9	80.9	78.8	79.8	1.1	1.
244	FILERS	6918	78.3	81.6	<75.0	77.8	3.3	3.8
131	GANG SAW OPERATOR	1025	77.9	79.2	77.9	79.2	0.0	0.0
182	TALLYMEN	4098	77.7	81.2	77.4	81.2	0.3	0.0
160	KILN OPERATOR	2817	77.0	80.5	76.9	80.5	0.1	0.0
114	DEBARKER OPERATOR	4866	77.0	82.3	77.0	82.3	0.0	0.0
262	CLEAN-UP MAN/DOWN TM	2049	76.3	77.7	75.9	77.3	0.4	0.4
111	LOG CARRIER OPER	512	76.0	76.0	76.0	76.0	0.0	0.0
219	MACHINISTS	4868	<75.0	77.5	<75.0	76.2	0.0	1.3
207	RAILCAR LOADER	3331	<75.0	77.1	<75.0	77.1	0.0	0.0
223	MECHANICS	5894	<75.0	<75.0	<75.0	<75.0	0.0	0.0
107	POND SORTER	1537	<75.0	<75.0	<75.0	<75.0	0.0	0.0
108	LOG SORTER	512	<75.0	<75.0	<75.0	<75.0	0.0	0.0
217	WELDER	256	<75.0	<75.0	<75.0	<75.0	0.0	0.0

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

TABLE 5-16
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	SOUND LEVEL BEFORE MEAN	SOUND LEVEL BEFORE W.C.	SOUND LEVEL AFTER MEAN	SOUND LEVEL AFTER W.C.	SOUND LEVEL CHANGE MEAN	SOUND LEVEL CHANGE W.C.
168	PLANER SET-UP MAN	3329	104.5	108.1	93.7	97.6	10.8	10.5
137	CHIPPER OPERATOR	2304	97.9	101.5	<90.0	90.7	7.9	10.8
128	QUADSAW TAIL SAWYER	512	97.0	97.0	97.0	97.0	0.0	0.0
127	TAIL SAWYER	1793	96.5	102.6	91.5	97.6	5.0	5.0
167	PLANER OPERATOR	7175	95.1	98.8	<90.0	<90.0	5.1	8.8
144	LUMBER DIVERTER	1792	94.2	96.3	<90.0	90.5	4.2	5.7
185	RIPSAW OPERATOR	256	94.0	94.0	94.0	94.0	0.0	0.0
138	HOG OPERATOR	1536	93.9	96.5	91.5	94.7	2.3	1.8
213	MILLWRIGHT/PLANER	1792	92.6	95.9	<90.0	<90.0	2.6	5.9
133	SLAB BOARD PULLER	512	92.5	93.2	<90.0	<90.0	2.5	3.2
186	RIPSAW OFFBEARER	256	92.0	92.0	92.0	92.0	0.0	0.0
212	MILLWRIGHT/SAWMILL	3643	91.2	91.8	<90.0	<90.0	1.2	1.8
173	GRADER/PLANER MILL	13837	91.0	93.2	<90.0	<90.0	1.0	3.2
245	OILER	1536	91.0	92.2	<90.0	<90.0	1.0	2.2
191	SPECIALTY RESAW OFFB	1280	90.8	96.3	90.1	96.0	0.7	0.3
190	SPECIALTY RESAW OPER	1024	90.3	97.9	<90.0	97.6	0.3	0.3
101	SAWMILL SUPERVISOR	3328	90.2	90.9	<90.0	<90.0	0.2	0.9
233	CARPENTERS	2049	<90.0	90.4	<90.0	82.6	0.0	0.4
140	RESAW OPERATOR	3075	<90.0	91.8	<90.0	86.8	0.0	1.8
104	PLANER SUPERVISOR	2561	<90.0	90.5	<90.0	77.1	0.0	0.5
211	MILLWRIGHT/GENERAL	14095	<90.0	91.2	<90.0	84.9	0.0	1.2
117	DECK SCALER	1024	<90.0	93.4	<90.0	88.5	0.0	3.4
151	GREEN CHAIN PULLER	7430	<90.0	93.7	<90.0	85.9	0.0	3.7
228	ELECTRICIANS	10506	<90.0	<90.0	<90.0	<90.0	0.0	0.0
261	CLEAN-UP MAN/REGULAR	2560	<90.0	90.2	<90.0	79.3	0.0	0.2
159	TRANSFER OPERATOR	1280	<90.0	103.1	<90.0	103.1	0.0	0.0
134	EDGER OPERATOR	6407	<90.0	98.6	<90.0	69.6	0.0	8.6
238	PIPE-FITTERS	768	<90.0	<90.0	<90.0	<90.0	0.0	0.0
143	UNSCRAMBLE OPERATOR	1280	<90.0	91.7	<90.0	0.0	0.0	1.7
265	LABORER	1792	<90.0	<90.0	<90.0	<90.0	0.0	0.0
216	SHOPMAN/GENERAL	256	<90.0	<90.0	<90.0	<90.0	0.0	0.0
148	TRIMMER OPERATOR	9479	<90.0	94.2	<90.0	82.5	0.0	4.2
266	HELPER	2561	<90.0	<90.0	<90.0	<90.0	0.0	0.0
120	CUT-OFF SAW OPERATOR	512	<90.0	<90.0	<90.0	<90.0	0.0	0.0

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

TABLE 5-16 (Cont'd)

EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
219	MACHINISTS	4868	<90.0	<90.0	<90.0	<90.0	0.0	0.0
196	MOULDER FEEDER	768	<90.0	<90.0	<90.0	<90.0	0.0	0.0
179	BANDER OPERATOR	2304	<90.0	<90.0	<90.0	<90.0	0.0	0.0
161	UNSTACKER-DRY	1793	<90.0	<90.0	<90.0	<90.0	0.0	0.0
244	FILERS	6918	<90.0	<90.0	<90.0	<90.0	0.0	0.0
262	CLEAN-UP MAN/DOWN TM	2049	<90.0	<90.0	<90.0	<90.0	0.0	0.0
114	DEBARKER OPERATOR	4866	<90.0	<90.0	<90.0	<90.0	0.0	0.0
182	TALLYMEN	4098	<90.0	<90.0	<90.0	<90.0	0.0	0.0
176	DRY CHAIN PULLER	23321	<90.0	<90.0	<90.0	<90.0	0.0	0
107	POND SORTER	1537	<90.0	<90.0	<90.0	<90.0	0.0	0.
108	LOG SORTER	512	<90.0	<90.0	<90.0	<90.0	0.0	0.0
111	LOG CARRIER OPER	512	<90.0	<90.0	<90.0	<90.0	0.0	0.0
123	SAWYER	5894	<90.0	<90.0	<90.0	<90.0	0.0	0.0
131	GANG SAW OPERATOR	1025	<90.0	<90.0	<90.0	<90.0	0.0	0.0
145	GREEN CHAIN OPERATOR	2817	<90.0	<90.0	<90.0	<90.0	0.0	0.0
154	STACKER-GREEN	7174	<90.0	90.4	<90.0	90.4	0.0	0.0
155	STICKERMAN-GREEN	4355	<90.0	90.1	<90.0	90.1	0.0	0.0
156	UNIPAC OPERATOR	512	<90.0	<90.0	<90.0	<90.0	0.0	0.0
160	KILN OPERATOR	2817	<90.0	<90.0	<90.0	<90.0	0.0	0.0
162	UNSTACKER PULLER	2818	<90.0	<90.0	<90.0	<90.0	0.0	0.0
163	GRADER/SORTING CHAIN	768	<90.0	91.3	<90.0	89.1	0.0	1.3
181	CHECKERS	1537	<90.0	<90.0	<90.0	<90.0	0.0	0.0
197	MOULDER OFFBEARER	768	<90.0	<90.0	<90.0	<90.0	0.0	0.0
201	LUMBER CARRIER OPER	5125	<90.0	<90.0	<90.0	<90.0	0.0	0.0
202	FORKLIFT OPERATOR	14607	<90.0	<90.0	<90.0	<90.0	0.0	0.0
207	RAILCAR LOADER	3331	<90.0	<90.0	<90.0	<90.0	0.0	0.0
217	WELDER	256	<90.0	<90.0	<90.0	<90.0	0.0	0.0
223	MECHANICS	5894	<90.0	<90.0	<90.0	<90.0	0.0	0.0
248	POWERHOUSE OPERATOR	4611	<90.0	<90.0	<90.0	<90.0	0.0	0.0

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ENVIRONMENTAL PROTECTION AGENCY                    BBN JOB NO.   9635
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TABLE 5-17

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              EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE

                              EPA CRITERIA

SIC CODE =  242          AVERAGE FOR INDUSTRY          NO DATES SPECIFIED


***************************************************************** .

                                             BEFORE CHANGE     AFTER CHANGE

TOTAL NO. OF PERSONNEL                          231700            231700
TOTAL NO OF PERS. WITH LEQ>75 (MEAN)            208632            208119
TOTAL NO OF PERS. WITH LEQ>75 (W.C.)            212477            211964
TOTAL NO OF PERS. WITH LEQ>90 (MEAN)             64588             18966
TOTAL NO OF PERS. WITH LEQ>90 (W.C.)            133535             57925
LEVEL WEIGHTED POPULATION (MEAN)              1078540.0          590931.2
LEVEL WEIGHTED POPULATION (W.C.)              1625903.0         1036873.9

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TABLE 5-18

EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

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		BEFORE CHANGE	AFTER CHANGE
TOTAL NUMBER OF PERSONNEL	=	231700	231700
TOTAL NUMBER OVEREXPOSED (MEAN)	=	57668	9995
TOTAL NUMBER OVEREXPOSED (W.C.)	=	92526	41265

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ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-19 EQUIPMENT NOISE IMPACT AVERAGES

EPA CRITERIA

AFTER NOISE CONTROL ON SELECTED EQUIPMENT

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1688	KILN CHAIN	68	85.7	91.4	175454	28967.8	0.139
1699	PLANER	46	88.3	91.9	312306	27894.2	0.134
1620	HEADRIG	24	80.2	85.0	118338	23319.9	0.112
1739	DRY CHAIN	20	86.0	89.2	77110	18795.5	0.090
1800	FORKLIFT	9	86.6	90.2	34587	16577.4	0.080
1664	TRIMMER	33	81.5	89.1	212355	13377.5	0.064
1679	GREEN CHAIN	20	82.7	86.9	157521	12648.0	0.061
1629	EDGER	26	80.6	89.1	199547	11963.6	0.058
1644	RESAW/LARGE	14	81.2	84.4	78637	5729.7	0.028
1828	GANG SAW	4	76.8	78.6	75050	5692.4	0.027
1610	LUMBER CARRIER	8	85.4	87.8	17677	5309.8	0.026
1819	QUADSAW	3	94.0	94.0	54038	5025.9	0.024
1759	RESAW/SPECIALTY	15	94.3	98.6	92997	4615.1	0.022
1792	POWERHOUSE	5	86.8	91.2	9734	4600.6	0.022
1776	CONVEYOR/GEN	5	87.8	90.9	93488	4423.3	0.021
1600	DEBARKER	17	76.0	82.8	21516	4350.0	0.021
1785	HOG	8	95.1	100.5	40219	3388.1	0.016
1610	CUT-OFF	16	84.3	93.2	83513	2613.0	0.013
1779	CHIPPER	30	88.9	92.7	34315	2267.6	0.011
1749	STACK BANDER	6	81.2	83.9	3841	1612.3	0.008
1724	MOULDER	10	86.8	91.7	2304	1536.0	0.007
1685	KILN	7	83.6	89.6	3585	1328.5	0.006
1813	TRANSFER CARRIER	3	86.0	101.6	3840	1184.4	0.006
1848	RIP SAW/SPECIALTY	4	88.0	88.0	512	512.0	0.002
1808	LOG CARRIER	1	90.0	90.0	256	256.0	0.001
1798	SAWMILL OFFICE	1	70.0	70.0	768	11.3	0.000

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-20 EQUIPMENT NOISE CONTROL PRIORITY AVERAGES

AFTER NOISE CONTROL ON SELECTED EQUIPMENT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 242 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1679	GREEN CHAIN	20	82.7	86.9	3075	3075.0	0.308
1699	PLANER	46	88.3	91.9	3330	1793.0	0.179
1620	HEADRIG	24	80.2	85.0	3074	1537.0	0.154
1759	RESAW/SPECIALTY	15	94.3	98.6	1280	1280.0	0.128
1785	HOG	8	95.1	100.5	1792	1107.4	0.111
1848	RIP SAW/SPECIALTY	4	88.0	88.0	512	512.0	0.051
1819	QUADSAW	3	94.0	94.0	512	512.0	0.051
1779	CHIPPER	30	88.9	92.7	512	172.6	0.017

5.2 Foundry Industry Results - SIC 332

The results presented here were derived from data collected in seven different plants, all of which were selected at random. Figure 5-2 is an overview of the noise exposure problem and indicates the number of workers exposed to equivalent eight-hour noise levels equal to or greater than the value shown on the ordinate axis.

The results are presented in detail in Tables 5-21 to 5-40. These tables are similar to Tables 5-1 to 5-20 in Section 5.1 for the Sawmill Industry and need no further explanation.

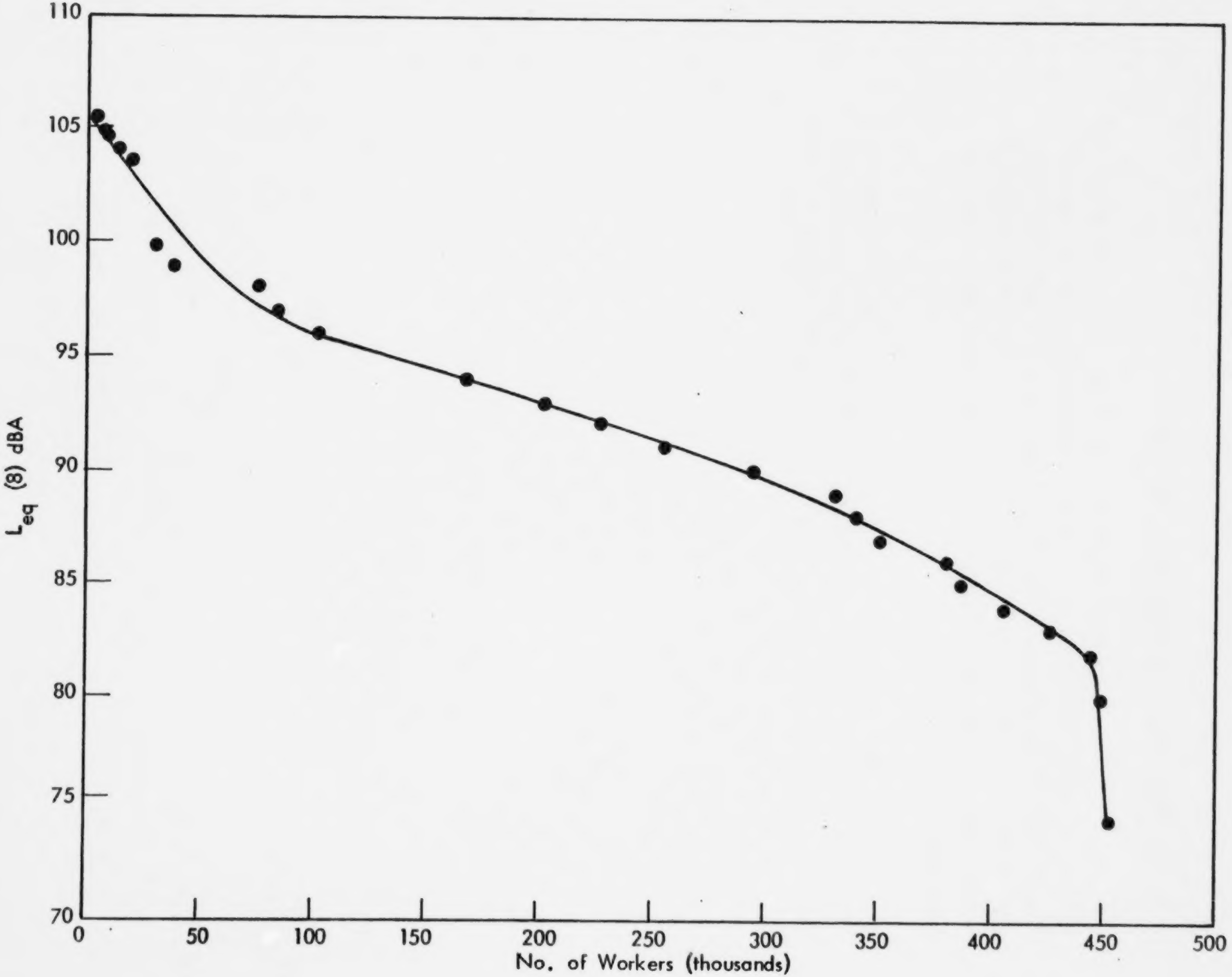

FIGURE 5.2 OVERVIEW OF THE NOISE EXPOSURE PROBLEM IN THE FOUNDRY INDUSTRY

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-21 PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. POP. MEAN	W.C.
27502	PN GRINDER OPER	53004	94.1	96.2	483086	597364
34004	SQUEZ/JOLT MOLDER OP	15388	98.4	104.9	211516	343924
30304	ARC WELDER/A	8549	95.3	102.1	116028	156488
30200	ARC-AIR OPERATOR	5129	103.5	107.3	103976	133500
30301	ARC WELDER/A	8549	96.7	100.4	100429	137419
27500	PN GRINDER OPER	11113	93.7	94.9	96808	110441
34003	SQUEZ/JOLT MOLDER OP	5984	98.4	104.9	82220	133737
31003	ARC AIR GOUGER	3419	104.9	105.7	76368	97128
34300	MOLDMASTER OPERATOR	5129	98.1	100.1	66540	80649
32600	ARC FURNACE OPERATOR	4274	98.9	102.8	61252	82457
42101	SHELL CORE OPERATOR	6839	93.6	95.0	59201	68248
28001	WHEEL GRINDER OPER	5129	96.2	103.1	57446	101462
28200	TRIM GRINDER OPER	3419	99.9	99.9	52984	52984
44300	SHAKEOUT TABLE OPER	3419	99.8	102.8	52781	66223
28101	STAND STONE GRINDER	8549	90.7	93.1	52557	69847
27503	PN GRINDER OPER	5129	93.1	95.5	41792	53976
27700	PN DISC GRINDER OPER	3419	97.0	99.9	41319	52940
28000	WHEEL GRINDER OPER	4274	94.5	100.4	40458	69018
36701	POURER	3419	96.6	100.2	39912	54494
31004	ARC AIR GOUGER	1709	105.5	109.3	39748	50281
31002	ARC AIR GOUGER	1709	104.9	108.7	38226	48564
31800	GAS BURNER	1709	104.6	108.4	37371	47643
31900	POWDER BURNER	1709	104.6	108.4	37371	47643
44000	SHAKEOUT OPERATOR	6839	89.7	92.5	37069	52435
31000	ARC AIR GOUGER	1709	104.3	108.1	36601	46705
45000	DUMPOUT/SHAKEOUT OP	1709	103.9	103.9	35784	35784
31001	ARC AIR GOUGER	1709	103.5	107.3	34625	44484
50500	CUT-OFF WHEEL OPER	2564	98.0	98.0	33934	33934
42103	SHELL CORE OPERATOR	4274	92.2	93.6	31682	36852
42203	NO-BAKE CORE OPER	4274	92.2	93.6	31682	36852
32500	FURNACE OPERATOR	3419	93.6	93.6	29435	29435
36704	POURER	5129	89.9	92.6	28609	39928
28102	STAND STONE GRINDER	4274	91.3	92.9	28418	34149
27901	SWING GRINDER OPER	3419	92.8	93.4	27055	28804
42102	SHELL CORE OPERATOR	3419	92.7	94.0	26902	30724
20203	FORKLIFT OPERATOR	1709	100.0	100.0	26681	26681
50400	RADIAL SAW OPERATOR	1709	99.9	99.9	26492	26492
36801	MELTER/POURER	5129	89.2	93.5	25900	44050
34002	SQUEZ/JOLT MOLDER OP	4274	90.3	93.9	24999	30041
50501	CUT-OFF WHEEL OPER	1709	99.1	99.1	24729	24729

ENVIRONMENTAL PROTECTION AGENCY　　　　BBN JOB NO.　9635

TABLE 5-21　PERSONNEL NOISE EXPOSURE AND IMPACT
(Cont'd)

EPA CRITERIA

SIC CODE = 332　　AVERAGE FOR INDUSTRY　　NO DATES SPECIFIED

JOB	JOB DESCRIPTION	NO. OF	SOUND	LEVEL	LEV. WT.	POP.
CODE		PERS.	MEAN	W.C.	MEAN	W.C.
33800	SHELLMOLDER OPERATOR	3419	91.7	93.8	23941	30246
34103	FLOOR MOLDER	3419	91.6	95.2	23615	34716
26402	SERVICEMAN	3419	91.0	91.0	21968	21968
40400	MACHINE BLASTER	3419	91.0	91.0	21968	21968
50502	CUT-OFF WHEEL OPER	1709	97.5	100.1	21666	26996
44002	SHAKEOUT OPERATOR	3419	90.9	93.5	21524	29235
36700	POURER	6839	88.1	88.5	21159	31187
44301	SHAKEOUT TABLE OPER	1709	97.2	102.7	21139	32887
27800	PN CONE GRINDER OPER	2564	93.1	95.1	21083	25829
50503	CUT-OFF WHEEL OPER	1709	97.0	99.5	20690	25758
34104	FLOOR MOLDER	3419	90.6	94.7	20683	33214
33001	LADLE PRE-HEATER	1709	96.9	105.8	20539	40680
28104	STAND STONE GRINDER	3419	90.4	92.4	20310	25943
26600	HELPER	5129	87.6	88.3	20278	22591
27902	SWING GRINDER OPER	2564	92.6	93.1	19850	21042
42600	CORE SETTER	2564	92.5	92.5	19571	19571
43301	CORE ROOM WORKER	14533	82.2	85.9	19023	42887
43300	CORE ROOM WORKER	5984	86.2	88.6	18633	27513
46701	WHELLABRATOR OPER	3419	89.6	95.2	18317	34760
26406	SERVICEMAN	3419	89.4	92.1	17746	25005
39500	SANDSLINGER OPERATOR	1709	95.1	99.2	17348	25045
26501	LABORER	5129	86.6	85.7	17162	24005
33901	AUTO-MOLDER OPERATOR	1709	94.6	96.7	16456	20142
33900	AUTO-MOLDER OPERATOR	1709	94.6	96.7	16442	20133
34001	SQUEZ/JOLT MOLDER OP	2564	90.7	95.6	15892	29995
50600	TABOR CUT-OFF SAW OP	1709	94.1	94.1	15591	15591
36800	MELTER/POURER	2564	89.9	94.3	14190	23832
34000	SQUEZ/JOLT MOLDER OP	1709	93.2	96.6	14146	23763
34102	FLOOR MOLDER	3419	87.9	87.9	14132	14132
33700	HI PRESS. MOLDER OP	1709	93.2	93.2	14114	14114
45900	SHIFTER	2564	89.5	90.7	13523	15845
34105	FLOOR MOLDER	1709	92.6	94.1	13280	15625
50200	BAND SAW OPERATOR	1709	92.5	92.5	13021	13021
40300	HAND BLASTER	1709	92.3	92.3	12837	12837
20300	WORKSAVER OPERATOR	5129	84.8	86.4	12319	16532
46101	INSPECTOR	854	98.6	98.6	11943	11943
40202	ROTOBLAST OPERATOR	1709	91.4	94.7	11482	16638
20202	FORKLIFT OPERATOR	1709	91.4	93.9	11475	15203
46703	WHELLABRATOR OPER	854	98.1	98.1	11362	11362
44001	SHAKEOUT OPERATOR	1709	91.1	94.2	11136	15816

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-21 PERSONNEL NOISE EXPOSURE AND IMPACT
(Cont'd)

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
40201	ROTOBLAST OPERATOR	1709	91.0	94.3	10984	15876
46700	WHELLABRATOR OPER	2564	88.0	89.7	10913	13667
36702	POURER	1709	91.0	91.0	10902	10902
28100	STAND STONE GRINDER	1709	90.7	92.6	10488	13210
36703	POURER	1709	90.4	90.4	10136	10136
28103	STAND STONE GRINDER	1709	90.4	92.4	10087	12923
42200	NO-BAKE CORE OPER	4274	84.6	84.9	9813	10550
48000	OVERHEAD CRANE OPER	1709	90.0	90.0	9617	9617
32700	INDUCT. FURNACE OPER	1709	90.0	94.3	9581	15945
46702	WHELLABRATOR OPER	1709	89.5	94.1	8982	15563
40203	ROTOBLAST OPERATOR	1709	89.4	93.5	8881	14707
53400	PRESS OPERATOR	5129	83.0	84.0	8207	10387
40500	SPIRALBLAST OPERATOR	854	94.5	94.5	8162	8162
48002	OVERHEAD CRANE OPER	1709	88.8	88.8	8120	8120
30300	ARC WELDER/A	2564	86.2	88.8	8053	8936
42900	OIL-BAKE COREMAKER	1709	88.6	88.6	7697	7697
32900	CUPOLA FURNACE OPER	1709	86.4	93.0	7666	13921
42104	SHELL CORE OPERATOR	854	93.6	95.0	7412	8540
30302	ARC WELDER/A	3419	84.1	85.5	7129	9458
48001	OVERHEAD CRANE OPER	1709	87.9	87.9	7071	7071
35000	MOLD WASH WORKER	854	92.5	92.5	6527	6527
27900	SWING GRINDER OPER	854	92.3	92.8	6425	6782
33100	LADLE SKIMMER	1709	87.3	90.1	6417	9782
27600	PN DRILL GRINDER OP	854	91.8	94.3	6060	7976
34100	FLOOR MOLDER	3419	83.3	87.1	5941	12558
48003	OVERHEAD CRANE OPER	1709	86.8	86.8	5915	5915
20200	FORKLIFT OPERATOR	1709	86.2	86.6	5371	7654
26404	SERVICEMAN	1709	86.1	90.5	5301	10263
32701	INDUCT. FURNACE OPER	854	90.6	95.0	5171	8508
26405	SERVICEMAN	1709	86.0	88.6	5166	7890
38800	SANDMULLER OPERATOR	854	90.5	90.5	5155	5155
27501	PN GRINDER OPER	854	90.4	92.2	5086	6288
38503	MULLER OPER	854	90.2	92.3	4969	6376
38502	MULLER OPER	854	90.0	92.1	4789	6249
32800	FURNACE CHARGER	854	89.9	92.6	4768	6654
26409	SERVICEMAN	3419	82.4	83.4	4711	6069
40200	ROTOBLAST OPERATOR	854	89.8	90.9	4669	5407
26503	LABORER	1709	85.4	85.5	4616	5644
40204	ROTOBLAST OPERATOR	854	89.6	91.7	4570	5961
46200	CUPOLA OPERATOR	854	89.4	93.4	4457	7263

TABLE 5-21 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND	LEVEL	LEV. WT.	POP.
			MEAN	W.C.	MEAN	W.C.
42700	CORE GLUER	854	89.4	90.5	4432	5115
30303	ARC WELDER/A	1709	85.0	87.1	4299	6260
38504	MULLER OPER	854	89.1	91.3	4234	5674
33101	LADLE SKIMMER	1709	84.9	86.2	4222	7493
38501	MULLER OPER	854	88.9	90.9	4137	5397
26401	SERVICEMAN	1709	84.7	86.6	4033	5764
33000	LADLE PRE-HEATER	1709	84.6	85.9	3901	5037
26400	SERVICEMAN	1709	84.1	84.1	3550	3550
26403	SERVICEMAN	1709	83.9	85.0	3386	4295
26500	LABORER	854	87.2	87.6	3162	3372
26407	SERVICEMAN	1709	83.6	87.6	3132	6839
26410	SERVICEMAN	1709	83.5	88.1	3069	7372
26502	LABORER	1709	83.5	88.1	3069	7372
33002	LADLE PRE-HEATER	1709	83.5	88.1	3069	7372
34101	FLOOR MOLDER	1709	83.5	88.1	3069	7372
27000	FOREMAN	854	86.9	89.4	3028	4425
30700	ACETYLENE WELDER	854	86.6	87.5	2874	3328
34200	PACEMAKER MOLDR OPER	854	86.5	89.3	2834	4358
46100	INSPECTOR	1709	83.0	84.2	2731	3632
42100	SHELL CORE OPERATOR	854	85.5	87.4	2361	3309
26408	SERVICEMAN	1709	81.2	82.3	1668	2273
42202	NO-BAKE CORE OPER	854	83.8	91.7	1667	5991
38500	MULLER OPER	854	83.5	84.4	1543	1687
42201	NO-BAKE CORE OPER	854	79.7	85.7	465	2920
20201	FORKLIFT OPERATOR	1709	<75.0	78.1	0	419
26504	LABORER	1709	<75.0	<75.0	0	0

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-22 PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
31004	ARC AIR GOUGER	1709	105.0	108.8	8.05	13.50
31002	ARC AIR GOUGER	1709	103.9	107.7	6.83	11.60
31003	ARC AIR GOUGER	3419	103.9	107.7	6.83	11.60
45000	DUMPOUT/SHAKEOUT OP	1709	103.5	103.5	6.52	6.52
31800	GAS BURNER	1709	103.3	107.1	6.34	10.77
31900	POWDER BURNER	1709	103.3	107.1	6.34	10.77
31000	ARC AIR GOUGER	1709	102.7	106.6	5.65	9.94
30200	ARC-AIR OPERATOR	5129	101.4	105.3	4.88	8.28
31001	ARC AIR GOUGER	1709	101.4	105.3	4.88	8.28
44300	SHAKEOUT TABLE OPER	3419	98.9	102.0	3.45	5.25
50501	CUT-OFF WHEEL OPER	1709	98.4	98.4	3.20	3.20
28200	TRIM GRINDER OPER	3419	98.3	98.3	3.17	3.17
50400	RADIAL SAW OPERATOR	1709	98.3	98.3	3.17	3.17
32600	ARC FURNACE OPERATOR	4274	98.0	101.9	3.02	5.18
34004	SQUEZ/JOLT MOLDER OP	15368	97.4	103.9	2.78	6.83
34003	SQUEZ/JOLT MOLDER OP	5984	97.4	103.9	2.78	6.83
20203	FORKLIFT OPERATOR	1709	97.3	97.3	2.77	2.77
34300	MOLDMASTER OPERATOR	5129	96.9	98.7	2.61	3.32
50502	CUT-OFF WHEEL OPER	1709	96.4	99.1	2.44	3.52
50500	CUT-OFF WHEEL OPER	2564	96.3	96.3	2.40	2.40
46703	WHELLABRATOR OPER	854	96.1	96.1	2.34	2.34
28001	WHEEL GRINDER OPER	5129	95.4	102.5	2.11	5.63
50503	CUT-OFF WHEEL OPER	1709	95.3	98.0	2.09	3.02
46101	INSPECTOR	854	95.2	95.2	2.06	2.06
27700	PN DISC GRINDER OPER	3419	94.7	97.8	1.92	2.93
44301	SHAKEOUT TABLE OPER	1709	94.4	100.0	1.84	4.03
33900	AUTO-MOLDER OPERATOR	1709	93.9	96.0	1.71	2.30
33901	AUTO-MOLDER OPERATOR	1709	93.9	96.0	1.71	2.30
36701	POURER	3419	93.7	97.5	1.68	2.83
28000	WHEEL GRINDER OPER	4274	93.5	98.8	1.63	3.39
50600	TABOR CUT-OFF SAW OP	1709	93.4	93.4	1.60	1.60
30304	ARC WELDER/A	8549	92.7	95.6	1.46	2.49
42101	SHELL CORE OPERATOR	6839	92.4	93.8	1.40	1.70
42104	SHELL CORE OPERATOR	854	92.4	93.8	1.40	1.70
33001	LADLE PRE-HEATER	1709	92.1	101.2	1.35	4.73
27901	SWING GRINDER OPER	3419	92.1	92.6	1.33	1.44

TABLE 5-22 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
27502	PN GRINDER OPER	53004	92.0	93.8	1.32	1.70
33700	HI PRESS. MOLDER OP	1709	92.0	92.0	1.31	1.31
27500	PN GRINDER OPER	11113	91.4	93.0	1.22	1.51
42600	CORE SETTER	2564	91.4	91.4	1.21	1.21
40500	SPIRALBLAST OPERATOR	854	91.4	91.4	1.21	1.21
32500	FURNACE OPERATOR	3419	91.3	91.3	1.20	1.20
27902	SWING GRINDER OPER	2564	91.1	91.7	1.16	1.26
27600	PN DRILL GRINDER OP	854	91.0	93.6	1.15	1.64
39500	SANDSLINGER OPERATOR	1709	91.0	94.9	1.14	1.96
40202	ROTOBLAST OPERATOR	1709	90.8	94.2	1.12	1.79
28102	STAND STONE GRINDER	4274	90.5	92.0	1.07	1.31
27800	PN CONE GRINDER OPER	2564	90.4	92.6	1.06	1.44
27503	PN GRINDER OPER	5129	90.3	93.1	1.05	1.54
50200	BAND SAW OPERATOR	1709	90.3	90.3	1.04	1.04
44001	SHAKEOUT OPERATOR	1709	90.1	93.4	1.01	1.60
40300	HAND BLASTER	1709	90.0	90.0	1.00	1.00
42102	SHELL CORE OPERATOR	3419	90.0	91.4	1.00	1.22
42103	SHELL CORE OPERATOR	4274	90.0	91.4	1.00	1.22
42203	NO-BAKE CORE OPER	4274	90.0	91.4	1.00	1.22
27900	SWING GRINDER OPER	854	<90.0	90.6	1.00	1.08
26402	SERVICEMAN	3419	<90.0	<90.0	0.99	0.99
40201	ROTOBLAST OPERATOR	1709	<90.0	93.3	0.99	1.58
40400	MACHINE BLASTER	3419	<90.0	<90.0	0.99	0.99
28101	STAND STONE GRINDER	8549	<90.0	92.4	0.98	1.39
30301	ARC WELDER/A	8549	<90.0	93.6	0.98	1.66
46701	WHELLABRATOR OPER	3419	<90.0	94.7	0.87	1.91
35000	MOLD WASH WORKER	854	<90.0	<90.0	0.87	0.87
33800	SHELLMOLDER OPERATOR	3419	<90.0	91.2	0.83	1.18
32701	INDUCT. FURNACE OPER	854	<90.0	93.6	0.80	1.64
38502	MULLER OPER	854	<90.0	90.5	0.76	1.08
38503	MULLER OPER	854	<90.0	90.5	0.76	1.08
44002	SHAKEOUT OPERATOR	3419	<90.0	91.3	0.76	1.20
34105	FLOOR MOLDER	1709	<90.0	<90.0	0.74	0.92
28100	STAND STONE GRINDER	1709	<90.0	90.3	0.74	1.04
28103	STAND STONE GRINDER	1709	<90.0	90.3	0.74	1.04
28104	STAND STONE GRINDER	3419	<90.0	90.3	0.74	1.04

TABLE 5-22
(Cont'd)

PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
32700	INDUCT. FURNACE OPER	1709	<90.0	92.4	0.69	1.40
36800	MELTER/POURER	2564	<90.0	92.4	0.69	1.40
40203	ROTOBLAST OPERATOR	1709	<90.0	92.0	0.66	1.32
38504	MULLER OPER	854	<90.0	<90.0	0.65	0.92
44000	SHAKEOUT OPERATOR	6839	<90.0	<90.0	0.63	1.00
46702	WHELLABRATOR OPER	1709	<90.0	92.1	0.62	1.35
27501	PN GRINDER OPER	854	<90.0	<90.0	0.62	0.87
34103	FLOOR MOLDER	3419	<90.0	91.0	0.61	1.15
34104	FLOOR MOLDER	3419	<90.0	91.0	0.61	1.15
34000	SQUEZ/JOLT MOLDER OP	1709	<90.0	92.8	0.60	1.46
36801	MELTER/POURER	5129	<90.0	91.1	0.57	1.17
38501	MULLER OPER	854	<90.0	<90.0	0.54	0.77
26806	ERVICEMAN	3419	<9 .0	<90 0	0. 3	0.54
20202	FORKLIFT OPERATOR	1709	<90.0	<90.0	0.46	0.66
34002	SQUEZ/JOLT MOLDER OP	4274	<90.0	<90.0	0.41	0.65
36702	POURER	1709	<90.0	<90.0	0.40	0.40
36703	POURER	1709	<90.0	<90.0	0.40	0.40
42700	CORE GLUER	854	<90.0	<90.0	0.40	0.49
34001	SQUEZ/JOLT MOLDER OP	2564	<90.0	<90.0	0.40	0.98
40204	ROTOBLAST OPERATOR	854	<90.0	<90.0	0.40	0.63
40200	ROTOBLAST OPERATOR	854	<90.0	<90.0	0.35	0.47
32800	FURNACE CHARGER	854	<90.0	<90.0	0.34	0.70
36704	POURER	5129	<90.0	<90.0	0.34	0.70
38800	SANDMULLER OPERATOR	854	<90.0	<90.0	0.30	0.30
42900	OIL-BAKE COREMAKER	1709	<90.0	<90.0	0.16	0.16
26501	LABORER	5129	<90.0	<90.0	0.11	0.23
45900	SHIFTER	2564	<90.0	<90.0	0.11	0.23
42200	NO-BAKE CORE OPER	4274	<90.0	<90.0	0.04	0.05
20200	FORKLIFT OPERATOR	1709	<90.0	<90.0	0.00	0.43
20201	FORKLIFT OPERATOR	1709	<90.0	<90.0	0.00	0.0
20300	WORKSAVER OPERATOR	5129	<90.0	<90.0	0.00	0.23
26400	SERVICEMAN	1709	<90.0	<90.0	0.00	0.0
26401	SERVICEMAN	1709	<90.0	<90.0	0.00	0.29
26403	SERVICEMAN	1709	<90.0	<90.0	0.00	0.0
26404	SERVICEMAN	1709	<90.0	<90.0	0.00	0.83
26405	SERVICEMAN	1709	<90.0	<90.0	0.00	0.57

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-22
(Cont'd)

PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL		DAILY NOISE DOSE	
			MEAN	W.C.	MEAN	W.C.
26407	SERVICEMAN	1709	<90.0	<90.0	0.00	0.42
26408	SERVICEMAN	1709	<90.0	<90.0	0.00	0.0
26409	SERVICEMAN	3419	<90.0	<90.0	0.00	0.0
26410	SERVICEMAN	1709	<90.0	<90.0	0.00	0.0
26500	LABORER	854	<90.0	<90.0	0.00	0.07
26502	LABORER	1709	<90.0	<90.0	0.00	0.0
26503	LABORER	1709	<90.0	<90.0	0.00	0.14
26504	LABORER	1709	<90.0	<90.0	0.00	0.0
26600	HELPER	5129	<90.0	<90.0	0.00	0.14
27000	FOREMAN	854	<90.0	<90.0	0.00	0.37
30300	ARC WELDER/A	2564	<90.0	<90.0	0.00	0.0
30302	ARC WELDER/A	3419	<90.0	<90.0	0.00	0.17
30303	ARC WELDER/A	1709	<90.0	<90.0	0.00	0.34
30700	ACETYLENE WELDER	854	<90.0	<90.0	0.00	0.0
32900	CUPOLA FURNACE OPER	1709	<90.0	91.9	0.00	1.30
33000	LADLE PRE-HEATER	1709	<90.0	<90.0	0.00	0.14
33002	LADLE PRE-HEATER	1709	<90.0	<90.0	0.00	0.0
33100	LADLE SKIMMER	1709	<90.0	<90.0	0.00	0.72
33101	LADLE SKIMMER	1709	<90.0	<90.0	0.00	0.42
34100	FLOOR MOLDER	3419	<90.0	<90.0	0.00	0.0
34101	FLOOR MOLDER	1709	<90.0	<90.0	0.00	0.0
34102	FLOOR MOLDER	3419	<90.0	<90.0	0.00	0.0
34200	PACEMAKER MOLDR OPER	854	<90.0	<90.0	0.00	0.58
36700	POURER	6839	<90.0	<90.0	0.00	0.43
38500	MULLER OPER	854	<90.0	<90.0	0.00	0.0
42100	SHELL CORE OPERATOR	854	<90.0	<90.0	0.00	0.29
42201	NO-BAKE CORE OPER	854	<90.0	<90.0	0.00	0.0
42202	NO-BAKE CORE OPER	854	<90.0	91.7	0.00	1.27
43300	CORE ROOM WORKER	5984	<90.0	<90.0	0.00	0.43
43301	CORE ROOM WORKER	14533	<90.0	<90.0	0.00	0.0
46100	INSPECTOR	1709	<90.0	<90.0	0.00	0.11
46200	CUPOLA OPERATOR	854	<90.0	91.9	0.00	1.30
46700	WHELLABRATOR OPER	2564	<90.0	<90.0	0.00	0.43
48000	OVERHEAD CRANE OPER	1709	<90.0	<90.0	0.00	0.0
48001	OVERHEAD CRANE OPER	1709	<90.0	<90.0	0.00	0.0
48002	OVERHEAD CRANE OPER	1709	<90.0	<90.0	0.00	0.0

ENVIRONMENTAL PROTECTION AGENCY

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TABLE 5-22 (Cont'd) PERSONNEL NOISE EXPOSURE AND IMPACT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
48003	OVERHEAD CRANE OPER	1709	<90.0	<90.0	0.00	0.0
53400	PRESS OPERATOR	5129	<90.0	<90.0	0.00	0.0

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-23 PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. POP. MEAN	W.C.
275	PN GRINDER OPER	70100	93.9	95.9	626773	768070
340	SQUEZ/JOLT MOLDER OP	29919	96.3	102.3	348776	569463
303	ARC WELDER/A	24790	93.6	95.6	235939	318564
310	ARC AIR GOUGER	10255	104.6	106.5	225570	287184
421	SHELL CORE OPERATOR	16240	92.6	94.0	127559	147676
281	STAND STONE GRINDER	19660	90.7	92.8	121862	156074
367	POURER	18805	89.9	92.2	110720	146650
302	ARC-AIR OPERATOR	5129	103.5	107.3	103976	133500
505	CUT-OFF WHEEL OPER	7691	97.9	99.1	101020	111418
280	WHEEL GRINDER OPER	9403	95.4	101.9	97905	170481
341	FLOOR MOLDER	17094	88.3	91.2	80723	117619
443	SHAKEOUT TABLE OPER	5128	99.0	102.8	73921	99111
264	SERVICEMAN	23929	85.6	87.6	73735	101293
440	SHAKEOUT OPERATOR	11967	90.3	93.0	69730	97488
343	MOLDMASTER OPERATOR	5129	95.1	100.1	66540	80649
326	ARC FURNACE OPERATOR	4274	98.9	102.8	61252	82457
279	SWING GRINDER OPER	6837	92.7	93.2	53331	56629
282	TRIM GRINDER OPER	3419	99.9	99.9	52984	52984
467	WHELLABRATOR OPER	8546	90.0	93.6	49576	75573
422	NO-BAKE CORE OPER	10256	87.3	89.2	43628	56315
202	FORKLIFT OPERATOR	6836	87.8	90.1	43528	50158
277	PN DISC GRINDER OPER	3419	97.0	99.9	41319	52940
402	ROTOBLAST OPERATOR	6835	90.4	93.5	40587	58592
368	MELTER/POURER	7693	89.4	93.8	40091	67882
433	CORE ROOM WORKER	20517	83.4	86.7	37857	70401
318	GAS BURNER	1709	104.6	106.4	37371	47643
319	POWDER BURNER	1709	104.6	106.4	37371	47643
450	DUMPOUT/SHAKEOUT OP	1709	103.9	103.9	35784	35784
339	AUTO-MOLDER OPERATOR	3418	94.6	95.7	32899	40276
480	OVERHEAD CRANE OPER	6836	88.4	88.4	30725	30725
325	FURNACE OPERATOR	3419	93.6	93.6	29435	29435
265	LABORER	11110	82.6	84.5	28010	40395
330	LADLE PRE-HEATER	5127	88.3	93.3	27510	53090
504	RADIAL SAW OPERATOR	1709	99.9	99.9	26492	26492
338	SHELLMOLDER OPERATOR	3419	91.7	93.8	23941	30246
404	MACHINE BLASTER	3419	91.0	91.0	21968	21968
278	PN CONE GRINDER OPER	2564	93.1	95.1	21083	25829
266	HELPER	5129	87.6	88.3	20278	22591
385	MULLER OPER	4270	88.3	93.2	19674	25585
426	CORE SETTER	2564	92.5	92.5	19571	19571

TABLE 5-23 PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES
(Cont'd)

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND MEAN	LEVEL W.C.	LEV. WT. MEAN	POP. W.C.
395	SANDSLINGER OPERATOR	1709	95.1	99.2	17348	25045
506	TABOR CUT-OFF SAW OP	1709	94.1	94.1	15591	15591
327	INDUCT. FURNACE OPER	2563	90.2	94.5	14753	24454
461	INSPECTOR	2563	88.2	89.0	14674	15576
337	HI PRESS. MOLDER OP	1709	93.2	93.2	14114	14114
459	SHIFTER	2564	89.5	90.7	13523	15645
502	BAND SAW OPERATOR	1709	92.5	92.5	13021	13021
403	HAND BLASTER	1709	92.3	92.3	12837	12837
203	WORKSAVER OPERATOR	5129	84.8	85.4	12319	16532
331	LADLE SKIMMER	3418	86.1	89.2	10640	17275
534	PRESS OPERATOR	5129	83.0	84.0	8207	10387
405	SPIRALBLAST OPERATOR	854	94.5	94.5	8162	8162
429	OIL-BAKE COREMAKER	1709	88.6	88.6	7697	7897
329	CUPOLA FURNACE OPER	1709	88.4	93.0	7666	13921
350	MOLD WASH WORKER	854	92.5	92.5	6527	6527
276	PN. DRILL GRINDER OP	854	91.8	94.3	6060	7976
388	SANDMULLER OPERATOR	854	90.5	90.5	5155	5155
328	FURNACE CHARGER	854	89.9	92.6	4768	6654
462	CUPOLA OPERATOR	854	89.4	93.4	4457	7263
427	CORE GLUER	854	89.4	90.5	4432	5115
270	FOREMAN	854	86.9	89.4	3028	4425
307	ACETYLENE WELDER	854	86.6	87.5	2874	3328
342	PACEMAKER MOLDR OPER	854	86.5	89.3	2834	4358

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ENVIRONMENTAL PROTECTION AGENCY                        BBN JOB NO.   9635

TABLE 5-23   PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES
 (Cont'd)
                                 EPA CRITERIA

SIC CODE =  332          AVERAGE FOR INDUSTRY        NO DATES SPECIFIED




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TOTAL NUMBER OF PERSONNEL                                 453956
TOTAL NUMBER OF PERSONNEL WITH LEQ > 75 (MEAN)            450538
TOTAL NUMBER OF PERSONNEL WITH LEQ > 75 (W.C.)            452248
TOTAL NUMBER OF PERSONNEL WITH LEQ > 90 (MEAN)            290669
TOTAL NUMBER OF PERSONNEL WITH LEQ > 90 (W.C.)            337690
LEVEL WEIGHTED POPULATION (MEAN)                        3553913.0
LEVEL WEIGHTED POPULATION (W.C.)                        4687870.0

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TABLE 5-24 PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL MEAN	SOUND LEVEL W.C.	DAILY NOISE DOSE MEAN	DAILY NOISE DOSE W.C.
310	ARC AIR GOUGER	10255	103.5	107.4	6.54	11.09
450	DUMPOUT/SHAKEOUT OP	1709	103.5	103.5	6.52	6.52
318	GAS BURNER	1709	103.3	107.1	6.34	10.77
319	POWDER BURNER	1709	103.3	107.1	6.34	10.77
302	ARC-AIR OPERATOR	5129	101.4	105.3	4.88	8.28
282	TRIM GRINDER OPER	3419	98.3	98.3	3.17	3.17
504	RADIAL SAW OPERATOR	1709	98.3	98.3	3.17	3.17
326	ARC FURNACE OPERATOR	4274	98.0	101.9	3.02	5.18
443	SHAKEOUT TABLE OPER	5128	97.7	101.4	2.91	4.84
343	MOLDMASTER OPERATOR	5129	96.9	98.7	2.61	3.32
505	CUT-OFF WHEEL OPER	7691	96.7	97.8	2.52	2.96
340	SQUEZ/JOLT MOLDER OP	29919	95.4	101.8	2.11	5.14
277	PN DISC GRINDER OPER	3419	94.7	97.8	1.92	2.93
280	WHEEL GRINDER OPER	9403	94.6	101.0	1.89	4.61
339	AUTO-MOLDER OPERATOR	3418	93.9	96.0	1.71	2.30
506	TABOR CUT-OFF SAW OP	1709	93.4	93.4	1.60	1.60
337	HI PRESS. MOLDER OP	1709	92.0	92.0	1.31	1.31
275	PN GRINDER OPER	70100	91.8	93.6	1.28	1.65
279	SWING GRINDER OPER	6837	91.5	92.0	1.23	1.33
426	CORE SETTER	2564	91.4	91.4	1.21	1.21
405	SPIRALBLAST OPERATOR	854	91.4	91.4	1.21	1.21
325	FURNACE OPERATOR	3419	91.3	91.3	1.20	1.20
276	PN DRILL GRINDER OP	854	91.0	93.6	1.15	1.64
395	SANDSLINGER OPERATOR	1709	91.0	94.9	1.14	1.96
421	SHELL CORE OPERATOR	16240	90.9	92.4	1.14	1.40
278	PN CONE GRINDER OPER	2564	90.4	92.6	1.06	1.44
502	BAND SAW OPERATOR	1709	90.3	90.3	1.04	1.04
403	HAND BLASTER	1709	90.0	90.0	1.00	1.00
404	MACHINE BLASTER	3419	<90.0	<90.0	0.99	0.99
281	STAND STONE GRINDER	19660	<90.0	91.6	0.92	1.25
350	MOLD WASH WORKER	854	<90.0	<90.0	0.87	0.87
303	ARC WELDER/A	24790	<90.0	92.8	0.84	1.48
338	SHELLMOLDER OPERATOR	3419	<90.0	91.2	0.83	1.18
202	FORKLIFT OPERATOR	6836	<90.0	<90.0	0.81	0.97
402	ROTOBLAST OPERATOR	6835	<90.0	92.0	0.79	1.31
327	INDUCT. FURNACE OPER	2563	<90.0	92.8	0.73	1.48

ENVIRONMENTAL PROTECTION AGENCY

BBN JOB NO. 9635

TABLE 5-24
(Cont'd)

PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL		DAILY NOISE DOSE	
			MEAN	W.C.	MEAN	W.C.
440	SHAKEOUT OPERATOR	11967	<90.0	91.0	0.72	1.14
467	WHELLABRATOR OPER	8546	<90.0	92.4	0.71	1.40
461	INSPECTOR	2563	<90.0	<90.0	0.69	0.76
368	MELTER/POURER	7693	<90.0	91.6	0.61	1.25
385	MULLER OPER	4270	<90.0	<90.0	0.54	0.77
367	POURER	18805	<90.0	<90.0	0.47	0.94
330	LADLE PRE-HEATER	5127	<90.0	93.5	0.45	1.62
422	NO-BAKE CORE OPER	10256	<90.0	<90.0	0.43	0.63
427	CORE GLUER	854	<90.0	<90.0	0.40	0.49
328	FURNACE CHARGER	854	<90.0	<90.0	0.34	0.70
341	FLOOR MOLDER	17094	<90.0	<90.0	0.32	0.55
388	SANDMULLER OPERATOR	854	<90.0	<90.0	0.30	0.30
264	SERVICEMAN	23929	<90.0	<90.0	0.22	0.41
429	OIL-BAKE COREMAKER	1709	<90.0	<90.0	0.16	0.16
459	SHIFTER	2564	<90.0	<90.0	0.11	0.23
265	LABORER	11110	<90.0	<90.0	0.05	0.14
203	WORKSAVER OPERATOR	5129	<90.0	<90.0	0.00	0.23
266	HELPER	5129	<90.0	<90.0	0.00	0.14
270	FOREMAN	854	<90.0	<90.0	0.00	0.37
307	ACETYLENE WELDER	854	<90.0	<90.0	0.00	0.0
329	CUPOLA FURNACE OPER	1709	<90.0	91.9	0.00	1.30
331	LADLE SKIMMER	3418	<90.0	<90.0	0.00	0.57
342	PACEMAKER MOLDR OPER	854	<90.0	<90.0	0.00	0.58
433	CORE ROOM WORKER	20517	<90.0	<90.0	0.00	0.13
462	CUPOLA OPERATOR	854	<90.0	91.9	0.00	1.30
480	OVERHEAD CRANE OPER	6836	<90.0	<90.0	0.00	0.0
534	PRESS OPERATOR	5129	<90.0	<90.0	0.00	0.0

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ENVIRONMENTAL PROTECTION AGENCY
                                                              BBN JOB NO.    9635
TABLE 5-24    PERSONNEL NOISE EXPOSURE AND IMPACT AVERAGES
 (Cont'd)
                  THRESHOLD LEVEL          = 90.0 DBA
                  8-HR PERMISSIBLE LEVEL = 90.0 DBA
                  EXCHANGE RATE            = 5 DBA

SIC CODE =  332          AVERAGE FOR INDUSTRY        NO DATES SPECIFIED




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               TOTAL NUMBER OF PERSONNEL           = 453958
               TOTAL NUMBER OVEREXPOSED (MEAN) = 210308
               TOTAL NUMBER OVEREXPOSED (W.C.) = 286395

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ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-25 EQUIPMENT NOISE IMPACT

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	M.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1160	ARC AIR GOUGERS	7	106.4	110.3	306649	45306.1	0.101
1118	PN DISC GRINDER	7	99.7	102.8	270962	30862.8	0.069
1338	SQUEZ/JOLT MOLDER	17	99.9	106.4	265810	29893.9	0.066
1120	PN WHEEL GRINDER	15	95.3	98.1	279510	26342.6	0.058
1450	SHELL CORE	5	95.0	96.4	170950	20382.8	0.045
1119	PN CONE GRINDER	14	95.4	97.5	264979	20237.4	0.045
1486	SHAKEOUT	6	91.7	95.0	132474	19344.3	0.043
1517	STAND STONE GRIND	10	91.5	94.0	209413	18325.1	0.041
1438	INDUCT. FURNACE	7	91.0	96.1	166603	14970.2	0.033
1437	ARC FURNACE	3	100.3	104.1	79463	13342.6	0.030
1117	PN DRILL GRINDER	8	92.6	95.2	241904	11015.9	0.024
1387	SANDSLINGER	2	98.0	98.0	60681	10614.0	0.024
1194	ROTOBLAST	5	92.0	95.4	67515	10210.9	0.023
1440	FURNACE	2	89.5	94.4	136747	9745.5	0.022
1452	CORE OVEN	1	82.0	82.0	37614	9189.3	0.020
1535	VENTILATION	2	82.5	83.2	289729	9019.7	0.020
1513	WHEEL GRINDER	2	97.0	104.1	20513	8660.8	0.019
1146	PN TAMPER	7	95.1	99.7	23077	7857.5	0.017
1499	WHEELABRATOR	5	90.2	95.8	112813	7537.4	0.017
1512	SWING GRINDER	3	93.7	94.2	128218	7241.8	0.016
1508	CUT-OFF WHEEL	2	100.0	100.0	190612	6968.0	0.015
1451	NO-BAKE CORE	2	95.0	96.4	31629	6802.8	0.015
1492	SHAKEOUT TABLE	6	101.0	104.0	87175	6512.1	0.014
1193	ABRASIVE BLAST	1	92.0	92.0	6838	6411.7	0.014
1503	RADIAL SAW	1	102.0	102.0	22219	5596.1	0.012
1471	BACK/OVERHD CRANE	1	90.0	90.0	10255	5371.7	0.012
1490	SHAKEOUT CONVEYOR	1	105.0	105.0	88882	5265.1	0.012
1341	MOLDMASTER	3	101.0	103.6	6838	5049.0	0.011
1446	CRUCIBLE	1	95.0	95.0	10256	5012.6	0.011
1166	WELDING/ARC	3	83.0	86.5	146171	4902.3	0.011

TABLE 5-25 EQUIPMENT NOISE IMPACT
(Cont'd)

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1507	CUT-OFF WHEEL	3	99.0	101.6	32478	4682.6	0.010
1336	SHELL MOLDER	3	93.7	96.2	87160	4400.4	0.010
1335	AUTO-MOLDER	2	95.5	97.6	133329	4195.6	0.009
1542	COMPRESSED AIR	8	94.6	99.4	121360	4124.1	0.009
1374	MULLER	5	90.6	93.1	127346	4042.0	0.009
1443	LADLE PRE-HEAT	5	90.0	93.8	192297	3756.9	0.008
1502	BAND SAW	1	94.0	94.0	18800	3565.9	0.008
1493	BACK. ONLY CONTR.	0	80.4	83.8	83756	3168.4	0.007
1494	SHAKEOUT TABLE	2	101.0	106.7	5981	3122.5	0.007
1459	CORE SET LINE	1	93.0	93.0	86320	3048.1	0.007
1482	PN VIBRATOR	3	98.7	101.7	84614	2675.2	0.006
1552	BACK. ONLY CONTR.	0	77.9	84.9	166661	1943.9	0.004
1137	PN CHISEL	4	103.8	112.8	5126	1762.8	0.004
1373	SANDMULLER	3	87.7	98.8	87182	1753.2	0.004
1509	TABOR CUT-OFF WHL	1	95.0	95.0	1709	1682.5	0.004
1442	FURNACE	2	87.0	88.4	71790	1665.2	0.004
1491	SHAKEOUT CONVEYOR	1	98.0	98.0	8834	1630.5	0.004
1375	SAND HOPPER/VIB	5	97.8	100.1	5129	1593.0	0.004
1189	ABRASIVE BLAST	1	95.0	95.0	1709	1580.2	0.004
1337	HI-PRESS. MOLDER	1	92.0	92.0	48718	1531.7	0.003
1483	PN VIBRATOR	1	105.0	105.0	1709	1494.5	0.003
1397	EXHAUST FAN	1	92.0	92.0	32481	1258.4	0.003
1544	BACK. ONLY CONTR.	0	76.1	84.0	87173	1082.6	0.002
1195	SPIRALBLAST	1	98.0	98.0	854	757.4	0.002
1802	FORKLIFT	3	85.7	88.2	21367	345.0	0.001
1175	WELD/ACETYLENE	1	86.0	86.0	1708	181.0	0.000
1340	MOLDER-PACEMAKER	1	82.0	82.0	854	120.8	0.000

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-26 EQUIPMENT NOISE CONTROL PRIORITY

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	H.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1160	ARC AIR GOUGERS	7	106.4	110.3	27351	27298.7	0.130
1120	PN WHEEL GRINDER	15	95.3	98.1	69246	26398.7	0.126
1118	PN DISC GRINDER	7	99.7	102.8	56423	22562.0	0.107
1338	SQUEZ/JOLT MOLDER	17	99.9	106.4	23081	21739.5	0.103
1119	PN CONE GRINDER	14	95.4	97.6	66661	19103.7	0.091
1117	PN DRILL GRINDER	8	92.6	95.2	62406	11830.0	0.056
1513	WHEEL GRINDER	2	97.0	104.1	9403	7894.9	0.038
1437	ARC FURNACE	3	100.3	104.1	7693	7693.0	0.037
1450	SHELL CORE	5	95.0	96.4	7693	7693.0	0.037
1512	SWING GRINDER	3	93.7	94.2	5983	5983.0	0.028
1503	RADIAL SAW	1	102.0	102.0	5128	5128.0	0.024
1508	CUT-OFF WHEEL	2	100.0	100.0	4273	4273.0	0.020
1490	SHAKEOUT CONVEYOR	1	105.0	105.0	5126	3659.1	0.017
1492	SHAKEOUT TABLE	6	101.0	104.0	3419	3419.0	0.016
1446	CRUCIBLE	1	95.0	95.0	3419	3419.0	0.016
1335	AUTO-MOLDER	2	95.5	97.6	3418	3418.0	0.016
1507	CUT-OFF WHEEL	3	99.0	101.6	3418	3418.0	0.016
1494	SHAKEOUT TABLE	2	101.0	106.7	5981	3315.6	0.016
1341	MOLDMASTER	3	101.0	103.6	5129	3157.9	0.015
1459	CORE SET LINE	1	93.0	93.0	2564	2564.0	0.012
1517	STAND STONE GRIND	10	91.5	94.0	5983	2023.0	0.010
1375	SAND HOPPER/VIB	5	97.6	100.1	5129	1971.1	0.009
1137	PN CHISEL	4	103.8	112.8	1709	1709.0	0.008
1194	ROTOBLAST	5	92.0	95.4	1709	1709.0	0.008
1486	SHAKEOUT	6	91.7	95.0	1709	1709.0	0.008
1502	BAND SAW	1	94.0	94.0	1709	1709.0	0.008

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-26 (Cont'd) EQUIPMENT NOISE CONTROL PRIORITY

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1509	TABOR CUT-OFF WHL	1	95.0	95.0	1709	1709.0	0.008
1337	HI-PRESS. MOLDER	1	92.0	92.0	1709	1031.5	0.005
1195	SPIRALBLAST	1	98.0	98.0	854	854.0	0.004
1387	SANDSLINGER	2	98.0	98.0	1709	679.3	0.003
1491	SHAKEOUT CONVEYOR	1	98.0	98.0	1709	395.0	0.002
1499	WHEELABRATOR	5	90.2	95.8	854	225.5	0.001
1146	PN TAMPER	7	95.1	99.7	1709	132.9	0.001
1438	INDUCT. FURNACE	7	91.0	98.1	1709	106.4	0.001

TABLE 5-27
LIST OF GENERALIZED EQUIPMENT CODES

CODE	BEGIN	END	GENERAL DESCRIPTION
1103	1103	1124	PNEUMATIC GRINDER
1135	1135	1143	PNEUMATIC CHISEL
1144	1144	1151	PNEUMATIC TAMPER
1158	1158	1186	WELD/BURN/GOUGING
1187	1187	1199	ABRASIVE BLASTING
1333	1333	1356	MOLDER
1371	1371	1384	MULLER
1385	1385	1391	SANDSLINGER
1392	1392	1392	HYDRAULIC PUMP
1394	1394	1400	EXHAUST FAN
1434	1434	1443	FURNACE
1444	1444	1447	CRUCIBLE
1446	1446	1456	CORE OVEN
1457	1457	1459	CORE SET LINE
1460	1460	1479	LATHE
1480	1480	1483	PNEUMATIC VIBRATOR
1484	1484	1496	SHAKEOUT/DUMPOUT
1497	1497	1499	WHEELABRATOR
1500	1500	1504	SAW/METAL
1505	1505	1509	CUT-OFF WHEEL
1510	1510	1520	ELECTRIC GRINDERS
1525	1525	1527	HAMMERING

ENVIRONMENTAL PROTECTION AGENCY BEN JOB NO. 9635

TABLE 5-28 EQUIPMENT NOISE IMPACT AVERAGES

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	M.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1103	PNEUMATIC GRINDER	44	95.5	96.2	******	88458.7	0.196
1158	WELD/BURN/GOUGING	11	96.2	101.9	454728	50389.3	0.112
1333	MOLDER	28	97.6	103.5	542729	45191.3	0.100
1434	FURNACE	19	91.6	96.0	646960	43480.4	0.097
1484	SHAKEOUT/DUMPOUT	16	97.6	101.1	405102	39042.9	0.087
1448	CORE OVEN	9	93.9	95.3	240193	36374.9	0.081
1510	ELECTRIC GRINDERS	15	92.7	95.6	358144	34227.8	0.076
1187	ABRASIVE BLASTING	8	93.1	96.5	76916	18960.1	0.042
1505	CUT-OFF WHEEL	6	96.7	100.8	224799	13333.2	0.030
1385	SANDSLINGER	2	98.0	96.0	60681	10614.0	0.024
1500	SAW/METAL	2	98.0	96.0	41019	9162.0	0.020
1144	PNEUMATIC TAMPER	6	95.4	99.9	23077	7857.5	0.017
1497	WHEELABRATOR	5	90.2	95.8	112813	7537.4	0.017
1371	MULLER	13	92.6	98.1	219657	7388.1	0.016
1460	LATHE	2	92.0	92.0	10255	5371.7	0.012
1444	CRUCIBLE	1	95.0	95.0	10256	5012.6	0.011
1480	PNEUMATIC VIBRATOR	4	100.2	103.3	66323	4169.8	0.009
1457	CORE SET LINE	2	93.5	93.5	86320	3048.1	0.007
1135	PNEUMATIC CHISEL	4	103.8	112.8	5126	1762.8	0.004
1394	EXHAUST FAN	2	92.5	92.5	32481	1258.4	0.003
1392	HYDRAULIC PUMP	1	96.0	96.0	1709	163.9	0.000
1525	HAMMERING	2	96.0	101.7	2562	116.0	0.000

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TABLE 5-29 EQUIPMENT NOISE CONTROL PRIORITY AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 *AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1103	PNEUMATIC GRINDER	44	95.6	98.2	254756	79894.4	0.380
1333	MOLDER	28	97.6	103.6	33337	29346.9	0.140
1158	WELD/BURN/GOUGING	11	98.2	101.9	35900	27298.7	0.130
1510	ELECTRIC GRINDERS	15	92.7	95.6	21369	15900.9	0.076
1484	SHAKEOUT/DUMPOUT	16	97.6	101.1	17944	12497.6	0.059
1505	CUT-OFF WHEEL	6	98.7	100.8	9400	9400.0	0.045
1434	FURNACE	19	91.6	96.0	11111	7799.4	0.037
1448	CORE OVEN	9	93.9	95.3	7693	7693.0	0.037
1500	SAW/METAL	2	96.0	98.0	6837	6837.0	0.033
1444	CRUCIBLE	1	95.0	95.0	3419	3419.0	0.016
1457	CORE SET LINE	2	93.5	93.5	2564	2564.0	0.012
1187	ABRASIVE BLASTING	6	93.1	96.5	2563	2563.0	0.012
1371	MULLER	13	92.5	96.1	5129	1971.1	0.009
1135	PNEUMATIC CHISEL	4	103.8	112.8	1709	1709.0	0.008
1385	SANDSLINGER	2	98.0	98.0	1709	674.3	0.003
1497	WHEELABRATOR	5	90.2	95.6	854	225.5	0.001
1525	HAMMERING	2	96.0	101.7	854	190.5	0.001
1392	HYDRAULIC PUMP	1	96.0	96.0	1709	149.7	0.001
1144	PNEUMATIC TAMPER	8	95.4	99.9	1709	132.9	0.001

TABLE 5-30

INPUT NOISE REDUCTION DATA

EACH LINE SHOWS THE NOISE REDUCTION
SPECIFICATIONS FOR A RANGE OF EQUIPMENT CODES

CODE FOR BEGINNING OF RANGE	CODE FOR END OF RANGE	NOISE REDUCTION
1103	1124	10
1333	1356	10
1158	1186	10
1510	1520	5
1484	1496	8
1505	1509	6

TABLE 5-31 EFFECT OF EQUIPMENT NOISE CONTROL

BACKGROUND AND EQUIPMENT NOISE DATA AVERAGES (LEQ)

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	MEAN LEQ (DBA) AFTER	NOISE RED. (DBA)
1160	ARC AIR GOUGERS	7	106.4	96.4	10.0
1483	PN VIBRATOR	1	105.0	105.0	0.0
1490	SHAKEOUT CONVEYOR	1	105.0	97.0	8.0
1137	PN CHISEL	4	103.8	103.8	0.0
1503	RADIAL SAW	1	102.0	102.0	0.0
1341	MOLDMASTER	3	101.0	91.0	10.0
1492	SHAKEOUT TABLE	6	101.0	93.0	8.0
1494	SHAKEOUT TABLE	2	101.0	93.0	8.0
1437	ARC FURNACE	3	100.3	100.3	0.0
1508	CUT-OFF WHEEL	2	100.0	92.0	8.0
1338	SQUEZ/JOLT MOLDER	17	99.9	89.9	10.0
1118	PN DISC GRINDER	7	99.7	89.7	10.0
1507	CUT-OFF WHEEL	3	99.0	91.0	8.0
1482	PN VIBRATOR	3	98.7	98.7	0.0
1195	SPIRALBLAST	1	98.0	98.0	0.0
1387	SANDSLINGER	2	98.0	98.0	0.0
1453	FLEXIBLO CORE MKR	1	98.0	98.0	0.0
1491	SHAKEOUT CONVEYOR	1	98.0	90.0	8.0
1375	SAND HOPPER/VIB	5	97.6	97.6	0.0
1513	WHEEL GRINDER	2	97.0	92.0	5.0
1335	AUTO-MOLDER	2	95.5	85.5	10.0
1119	PN CONE GRINDER	14	95.4	85.4	10.0
1120	PN WHEEL GRINDER	15	95.3	85.3	10.0
1146	PN TAMPER	7	95.1	95.1	0.0
1189	ABRASIVE BLAST	1	95.0	95.0	0.0
1446	CRUCIBLE	1	95.0	95.0	0.0
1450	SHELL CORE	5	95.0	95.0	0.0
1451	NO-BAKE CORE	2	95.0	95.0	0.0
1509	TABOR CUT-OFF WHL	1	95.0	87.0	8.0
1542	COMPRESSED AIR	6	94.6	94.6	0.0
1477	HOIST	1	94.0	94.0	0.0
1502	BAND SAW	1	94.0	94.0	0.0
1336	SHELL MOLDER	3	93.7	83.7	10.0
1512	SWING GRINDER	3	93.7	88.7	5.0
1396	EXHAUST FAN	1	93.0	93.0	0.0
1459	CORE SET LINE	1	93.0	93.0	0.0
1117	PN DRILL GRINDER	8	92.6	82.6	10.0
1193	ABRASIVE BLAST	1	92.0	92.0	0.0

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TABLE 5-31 (Cont'd) EFFECT OF EQUIPMENT NOISE CONTROL

BACKGROUND AND EQUIPMENT NOISE DATA AVERAGES (LEQ)

SIC CODE = 332   AVERAGE FOR INDUSTRY   NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	MEAN LEQ (DBA) AFTER	NOISE RED. (DBA)
1194	ROTOBLAST	5	92.0	92.0	0.0
1337	HI-PRESS. MOLDER	1	92.0	82.0	10.0
1397	EXHAUST FAN	1	92.0	92.0	0.0
1486	SHAKEOUT	6	91.7	83.7	8.0
1517	STAND STONE GRIND	10	91.5	86.5	5.0
1339	MOLDER	1	91.0	81.0	10.0
1438	INDUCT. FURNACE	7	91.0	91.0	0.0
1374	MULLER	5	90.6	90.6	0.0
1499	WHEELABRATOR	5	90.2	90.2	0.0
1443	LADLE PRE-HEAT	5	90.0	90.0	0.0
1445	BACK/CRUCIBLE	1	90.0	90.0	0.0
1471	BACK/OVERHD CRANE	1	90.0	90.0	0.0
1440	FURNACE	2	89.5	89.5	0.0
1485	BACK/SHAKEOUT	10	89.3	83.1	6.2
1104	BACK/PN GRINDER	3	89.0	84.5	4.5
1506	BACK/CUTOFF WHEEL	6	88.2	81.6	6.6
1458	BACK/CORE SET LIN	1	88.0	88.0	0.0
1501	BACK/SAW/METAL	2	88.0	88.0	0.0
1511	BACK/ELEC GRINDER	3	88.0	82.8	5.2
1159	BACK/WLD/BRN/GOUG	4	87.8	81.5	6.2
1373	SANDMULLER	3	87.7	87.7	0.0
1386	BACK/SANDSLINGER	3	87.3	87.3	0.0
1395	BACK/EXHAUST FAN	1	87.0	85.6	1.4
1442	FURNACE	2	87.0	87.0	0.0
1175	WELD/ACETYLENE	1	86.0	76.0	10.0
1802	FORKLIFT	3	85.7	85.7	0.0
1498	BACK/WHEELABRATOR	2	85.5	85.5	0.0
1136	BACK/PN CHISEL	2	85.0	83.4	1.6
1188	BACK/ABRASV BLAST	1	85.0	84.1	0.9
1526	BACK/HAMMER	1	85.0	82.2	2.8
1334	BACK/MOLDERS	4	84.8	77.3	7.5
1372	BACK/MULLER	3	84.3	84.3	0.0
1543	BACK/COMPRSD AIR	6	83.8	83.5	0.3
1435	BACK/FURNACE	19	83.5	83.5	0.0
1536	BACK/VENTILATION	9	83.3	82.7	0.6
1102	BACK/FIN/GRINDERS	3	83.0	74.6	8.4
1145	BACK/PN TAMPER	2	83.0	83.0	0.0
1166	WELDING/ARC	3	83.0	73.0	10.0

TABLE 5-31 (Cont'd) EFFECT OF EQUIPMENT NOISE CONTROL

BACKGROUND AND EQUIPMENT NOISE DATA AVERAGES (LEQ)

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	AFTER	NOISE RED. (DBA)
1535	VENTILATION	2	82.5	82.5	0.0
1449	BACK/CORE EQUIP	3	82.3	82.3	0.0
1340	MOLDER-PACEMAKER	1	82.0	72.0	10.0
1452	CORE OVEN	1	82.0	82.0	0.0
1493	BACK. ONLY CONTR.	0	80.4	73.7	6.7
1551	BACK/EXHAUST FAN	3	79.7	79.2	0.5
1481	BACK/PN VIBRATOR	1	78.0	76.6	1.4
1552	BACK. ONLY CONTR.	0	77.9	78.0	-0.1
1544	BACK. ONLY CONTR.	0	76.1	75.7	0.3

TABLE 5-32 EFFECT OF EQUIPMENT NOISE CONTROL

EQUIPMENT NOISE DATA AVERAGES (LEQ) GENERALIZED

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO. OF SAMPLES	MEAN LEQ (DBA) BEFORE	MEAN LEQ (DBA) AFTER	NOISE RED. (DBA)
1135	PNEUMATIC CHISEL	4	103.8	103.8	0.0
1480	PNEUMATIC VIBRATOR	4	100.2	100.2	0.0
1505	CUT-OFF WHEEL	6	98.7	90.7	8.0
1158	WELD/BURN/GOUGING	11	98.2	88.2	10.0
1500	SAW/METAL	2	98.0	98.0	0.0
1385	SANDSLINGER	2	98.0	98.0	0.0
1333	MOLDER	26	97.8	87.8	10.0
1484	SHAKEOUT/DUMPOUT	16	97.6	89.6	8.0
1525	HAMMERING	2	96.0	96.0	0.0
1392	HYDRAULIC PUMP	1	96.0	96.0	0.0
1103	PNEUMATIC GRINDER	44	95.6	85.6	10.0
1144	PNEUMATIC TAMPER	6	95.4	95.4	0.0
1444	CRUCIBLE	1	95.0	95.0	0.0
1446	CORE OVEN	9	93.9	93.9	0.0
1457	CORE SET LINE	2	93.5	93.5	0.0
1187	ABRASIVE BLASTING	8	93.1	93.1	0.0
1510	ELECTRIC GRINDERS	15	92.7	87.7	5.0
1371	MULLER	13	92.6	92.6	0.0
1394	EXHAUST FAN	2	92.5	92.5	0.0
1460	LATHE	2	92.0	92.0	0.0
1434	FURNACE	19	91.6	91.6	0.0
1497	WHEELABRATOR	5	90.2	90.2	0.0

TABLE 5-33
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	--- LEVEL WEIGHTED POPULATION --- BEFORE MEAN	W.C.	AFTER MEAN	W.C.	CHANGE MEAN	W.C.
275	PN GRINDER OPER	70100	626773	768070	152382	215659	474391	552411
340	SQUEZ/JOLT MOLDER OP	29919	348776	569463	129040	256260	219736	313203
303	ARC WELDER/A	24790	235939	318564	70030	119127	165909	199437
310	ARC AIR GOUGER	10255	225570	287184	99629	141467	125941	145717
421	SHELL CORE OPERATOR	16240	127559	147676	124861	147014	2698	662
281	STAND STONE GRINDER	19660	121862	156074	56821	76535	65041	79539
367	POURER	18805	110720	146650	91893	128713	18827	17937
302	ARC-AIR OPERATOR	5129	103976	133500	44362	63872	59614	69628
505	CUT-OFF WHEEL OPER	7691	101020	111418	44003	50641	57017	60777
280	WHEEL GRINDER OPER	9403	97905	170481	53880	112451	44025	58030
341	FLOOR MOLDER	17094	80723	117619	77344	115025	3379	2594
443	SHAKEOUT TABLE OPER	5128	73921	99111	33613	50578	40308	48
264	SERVICEMAN	23929	73735	101293	55698	85261	18037	16032
440	SHAKEOUT OPERATOR	11967	69730	97488	25701	29602	44029	67886
343	MOLDMASTER OPERATOR	5129	68540	80649	46283	57164	22257	23485
326	ARC FURNACE OPERATOR	4274	61252	82457	61251	82456	1	1
279	SWING GRINDER OPER	6837	53331	56629	27312	29700	26019	26929
282	TRIM GRINDER OPER	3419	52984	52984	52984	52984	0	0
467	WHELLABRATOR OPER	8546	49576	75573	36512	61277	13064	14296
422	NO-BAKE CORE OPER	10256	43628	56315	42711	54705	917	1610
202	FORKLIFT OPERATOR	6836	43528	50158	19089	21648	24439	28510
277	PN DISC GRINDER OPER	3419	41319	52940	13358	19640	27961	33300
402	ROTOBLAST OPERATOR	6835	40587	58592	39195	57520	1392	1072
368	MELTER/POURER	7693	40091	67882	38043	66933	2048	949
433	CORE ROOM WORKER	20517	37857	70401	29534	68829	8323	1572
318	GAS BURNER	1709	37371	47643	16375	23380	20996	24263
319	POWDER BURNER	1709	37371	47643	16375	23380	20996	24263
450	DUMPOUT/SHAKEOUT OP	1709	35784	35784	18746	18746	17038	17038
339	AUTO-MOLDER OPERATOR	3418	32899	40276	8541	12196	24358	28080
480	OVERHEAD CRANE OPER	6836	30725	30725	29436	29436	1289	1289
325	FURNACE OPERATOR	3419	29435	29435	28633	28633	802	802
265	LABORER	11110	28010	40395	21998	43720	6012	-3325
330	LADLE PRE-HEATER	5127	27510	53090	26622	55022	888	-1932
504	RADIAL SAW OPERATOR	1709	26492	26492	26492	26492	0	0
338	SHELLMOLDER OPERATOR	3419	23941	30246	5133	7660	18808	22586
404	MACHINE BLASTER	3419	21968	21968	21834	21834	134	134
278	PN CONE GRINDER OPER	2564	21083	25829	5537	5537	15546	20
266	HELPER	5129	20278	22591	18636	36912	1642	-14321

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TABLE 5-33 (Cont'd)
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

EPA CRITERIA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	--- LEVEL WEIGHTED POPULATION --- BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C. ---
385	MULLER OPER	4270	19674	25585	18634	24860	1040	725
426	CORE SETTER	2564	19571	19571	18839	18839	732	732
395	SANDSLINGER OPERATOR	1709	17348	25045	11554	11554	5794	13491
506	TABOR CUT-OFF SAW OP	1709	15591	15591	5259	5259	10332	10332
327	INDUCT. FURNACE OPER	2563	14753	24454	13141	23724	1612	730
461	INSPECTOR	2563	14674	15576	6764	7157	7910	8419
337	HI PRESS. MOLDER OP	1709	14114	14114	6874	6874	7240	7240
459	SHIFTER	2564	13523	15845	7467	11207	6056	4638
502	BAND SAW OPERATOR	1709	13021	13021	13021	13021	0	0
403	HAND BLASTER	1709	12837	12837	12620	12620	217	217
203	WORKSAVER OPERATOR	5129	12319	16532	3075	3075	9244	13457
331	LADLE SKIMMER	3418	10640	17275	6540	11093	4100	6182
534	PRESS OPERATOR	5129	8207	10387	0	444	8207	9943
405	SPIRALBLAST OPERATOR	854	8162	8162	7908	7908	254	254
429	OIL-BAKE COREMAKER	1709	7897	7897	7834	7834	63	63
329	CUPOLA FURNACE OPER	1709	7666	13921	7664	13920	2	1
350	MOLD WASH WORKER	854	6527	6527	2399	2399	4128	4128
276	PN DRILL GRINDER OP	854	6060	7976	1216	2023	4844	5953
388	SANDMULLER OPERATOR	854	5155	5155	3449	3449	1706	1706
328	FURNACE CHARGER	854	4768	6654	3962	6168	806	486
462	CUPOLA OPERATOR	854	4457	7263	3815	6952	642	311
427	CORE GLUER	854	4432	5115	3777	4575	655	540
270	FOREMAN	854	3028	4425	2326	3966	702	459
307	ACETYLENE WELDER	854	2874	3328	946	1338	1928	1990
342	PACEMAKER MOLDR OPER	854	2834	4358	830	1501	2004	2857

ENVIRONMENTAL PROTECTION AGENCY

BBN JOB NO. 9635

TABLE 5-34
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	DAILY NOISE DOSE BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
310	ARC AIR GOUGER	10255	6.54	11.09	1.63	2.76	4.92	8.33
450	DUMPOUT/SHAKEOUT OP	1709	6.52	6.52	2.15	2.15	4.37	4.37
318	GAS BURNER	1709	6.34	10.77	1.58	2.69	4.75	8.08
319	POWDER BURNER	1709	6.34	10.77	1.58	2.69	4.75	8.08
302	ARC-AIR OPERATOR	5129	4.88	8.28	1.22	2.07	3.66	6.21
282	TRIM GRINDER OPER	3419	3.17	3.17	3.17	3.17	0.0	0.0
504	RADIAL SAW OPERATOR	1709	3.17	3.17	3.17	3.17	0.0	0.0
326	ARC FURNACE OPERATOR	4274	3.02	5.18	3.02	5.18	0.0	0.0
443	SHAKEOUT TABLE OPER	5128	2.91	4.84	0.96	1.60	1.95	3.24
343	MOLDMASTER OPERATOR	5129	2.61	3.32	1.41	1.82	1.21	1.[illegible]
505	CUT-OFF WHEEL OPER	7691	2.52	2.96	0.83	0.98	1.69	1.99
340	SQUEZ/JOLT MOLDER OP	29919	2.11	5.14	0.04	1.31	2.07	3.83
277	PN DISC GRINDER OPER	3419	1.92	2.93	0.00	0.73	1.92	2.20
280	WHEEL GRINDER OPER	9403	1.89	4.61	0.82	2.17	1.08	2.44
339	AUTO-MOLDER OPERATOR	3418	1.71	2.30	0.00	0.0	1.71	2.30
506	TABOR CUT-OFF SAW OP	1709	1.60	1.60	0.00	0.0	1.60	1.60
337	HI PRESS. MOLDER OP	1709	1.31	1.31	0.22	0.22	1.09	1.09
275	PN GRINDER OPER	70100	1.28	1.65	0.00	0.17	1.28	1.48
279	SWING GRINDER OPER	6837	1.23	1.33	0.00	0.0	1.23	1.33
426	CORE SETTER	2564	1.21	1.21	1.21	1.21	0.0	0.0
405	SPIRALBLAST OPERATOR	854	1.21	1.21	1.21	1.21	0.0	0.0
325	FURNACE OPERATOR	3419	1.20	1.20	1.20	1.20	0.0	0.0
276	PN DRILL GRINDER OP	854	1.15	1.64	0.00	0.0	1.15	1.64
395	SANDSLINGER OPERATOR	1709	1.14	1.96	0.68	0.68	0.46	1.28
421	SHELL CORE OPERATOR	16240	1.14	1.40	1.14	1.41	0.0	-0.02
278	PN CONE GRINDER OPER	2564	1.06	1.44	0.00	0.0	1.06	1.44
502	BAND SAW OPERATOR	1709	1.04	1.04	1.04	1.04	0.0	0.0
403	HAND BLASTER	1709	1.00	1.00	1.00	1.00	0.0	0.0
404	MACHINE BLASTER	3419	0.99	0.99	0.99	0.99	0.0	0.0
281	STAND STONE GRINDER	19660	0.92	1.25	0.00	0.0	0.92	1.25
350	MOLD WASH WORKER	854	0.87	0.87	0.00	0.0	0.87	0.87
303	ARC WELDER/A	24790	0.84	1.48	0.21	0.36	0.63	1.12
338	SHELLMOLDER OPERATOR	3419	0.83	1.16	0.00	0.0	0.83	1.16
202	FORKLIFT OPERATOR	6836	0.81	0.97	0.24	0.25	0.57	0.72

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

TABLE 5-34 (Cont'd)

EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	DAILY NOISE DOSE BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
402	ROTOBLAST OPERATOR	6835	0.79	1.31	0.79	1.31	0.0	0.0
327	INDUCT. FURNACE OPER	2563	0.73	1.48	0.73	1.48	0.0	0.0
440	SHAKEOUT OPERATOR	11967	0.72	1.14	0.00	0.0	0.72	1.14
467	WHELLABRATOR OPER	8546	0.71	1.40	0.59	1.15	0.12	0.25
461	INSPECTOR	2563	0.69	0.76	0.33	0.33	0.36	0.43
368	MELTER/POURER	7693	0.61	1.25	0.61	1.25	0.0	0.0
385	MULLER OPER	4270	0.54	0.77	0.54	0.77	0.0	0.0
367	POURER	18805	0.47	0.94	0.47	0.78	0.0	0.16
330	LADLE PRE-HEATER	5127	0.45	1.52	0.45	1.58	0.0	0.05
422	NO-BAKE CORE OPER	10256	0.43	0.63	0.43	0.63	0.0	0.01
427	CORE GLUER	854	0.40	0.49	0.40	0.49	0.0	0.0
328	FURNACE CHARGER	854	0.34	0.70	0.34	0.70	0.0	0.0
341	FLOOR MOLDER	17094	0.32	0.55	0.32	0.55	0.0	0.0
388	SANDMULLER OPERATOR	854	0.30	0.30	0.00	0.0	0.30	0.30
264	SERVICEMAN	23929	0.22	0.41	0.22	0.36	0.0	0.05
429	OIL-BAKE COREMAKER	1709	0.16	0.16	0.16	0.16	0.0	0.0
459	SHIFTER	2564	0.11	0.23	0.11	0.23	0.0	0.0
265	LABORER	11110	0.05	0.14	0.05	0.28	0.0	-0.15
203	WORKSAVER OPERATOR	5129	0.00	0.23	0.00	0.0	0.0	0.23
266	HELPER	5129	0.00	0.14	0.00	1.25	0.0	-1.10
270	FOREMAN	854	0.00	0.37	0.00	0.37	0.0	0.0
307	ACETYLENE WELDER	854	0.00	0.0	0.00	0.0	0.0	0.0
329	CUPOLA FURNACE OPER	1709	0.00	1.30	0.00	1.30	0.0	0.0
331	LADLE SKIMMER	3418	0.00	0.57	0.00	0.21	0.0	0.36
342	PACEMAKER MOLDR OPER	854	0.00	0.58	0.00	0.0	0.0	0.58
433	CORE ROOM WORKER	20517	0.00	0.13	0.00	0.14	0.0	-0.01
462	CUPOLA OPERATOR	854	0.00	1.30	0.00	1.30	0.0	0.0
480	OVERHEAD CRANE OPER	6836	0.00	0.0	0.00	0.0	0.0	0.0
534	PRESS OPERATOR	5129	0.00	0.0	0.00	0.0	0.0	0.0

EPA CRITERIA

TABLE 5-35

EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	SOUND LEVEL BEFORE MEAN	W.C.	AFTER MEAN	W.C.	CHANGE MEAN	W.C.
310	ARC AIR GOUGER	10255	104.6	108.5	94.7	98.5	10.0	10.0
318	GAS BURNER	1709	104.6	108.4	94.6	98.4	10.0	10.0
319	POWDER BURNER	1709	104.6	108.4	94.6	98.4	10.0	10.0
450	DUMPOUT/SHAKEOUT OP	1709	103.9	103.9	95.9	95.9	8.0	8.0
302	ARC-AIR OPERATOR	5129	103.5	107.3	93.6	97.3	9.9	9.9
282	TRIM GRINDER OPER	3419	99.9	99.9	99.9	99.9	0.0	0.0
504	RADIAL SAW OPERATOR	1709	99.9	99.9	99.9	99.9	0.0	0.0
443	SHAKEOUT TABLE OPER	5128	99.0	102.6	91.2	94.9	7.8	7.9
326	ARC FURNACE OPERATOR	4274	98.9	102.8	98.9	102.8	0.0	0.0
343	MOLDMASTER OPERATOR	5129	98.1	100.1	94.0	96.1	4.1	4.0
505	CUT-OFF WHEEL OPER	7691	97.9	99.1	90.1	91.2	7.8	7.8
277	PN DISC GRINDER OPER	3419	97.0	99.9	87.5	90.2	9.5	9[illegible]
340	SQUEZ/JOLT MOLDER OP	29919	96.3	102.3	88.1	93.3	8.3	8.9
280	WHEEL GRINDER OPER	9403	95.4	101.9	90.1	96.8	5.3	5.1
395	SANDSLINGER OPERATOR	1709	95.1	99.2	91.4	91.4	3.7	7.8
339	AUTO-MOLDER OPERATOR	3418	94.6	96.7	85.0	86.9	9.6	9.8
405	SPIRALBLAST OPERATOR	854	94.5	94.5	94.2	94.2	0.3	0.3
506	TABOR CUT-OFF SAW OP	1709	94.1	94.1	86.1	86.1	8.0	8.0
275	PN GRINDER OPER	70100	93.9	95.9	84.3	86.1	9.6	9.8
303	ARC WELDER/A	24790	93.6	96.6	84.5	87.9	9.1	8.7
325	FURNACE OPERATOR	3419	93.6	93.6	93.3	93.3	0.3	0.3
337	HI PRESS. MOLDER OP	1709	93.2	93.2	87.7	87.7	5.5	5.5
278	PN CONE GRINDER OPER	2564	93.1	95.1	84.3	84.3	8.8	10.8
279	SWING GRINDER OPER	6837	92.7	93.2	87.6	88.2	5.0	5.0
421	SHELL CURE OPERATOR	16240	92.6	94.0	92.4	94.0	0.2	0.0
350	MOLD WASH WORKER	854	92.5	92.5	85.6	85.6	6.9	6.9
426	CORE SETTER	2564	92.5	92.5	92.1	92.1	0.3	0.3
502	BAND SAW OPERATOR	1709	92.5	92.5	92.5	92.5	0.0	0.0
403	HAND BLASTER	1709	92.3	92.3	92.2	92.2	0.1	0.1
276	PN DRILL GRINDER OP	854	91.8	94.3	82.5	84.7	9.3	9.6
338	SHELLMOLDER OPERATOR	3419	91.7	93.8	82.7	84.5	9.0	9.3
404	MACHINE BLASTER	3419	91.0	91.0	91.0	91.0	0.0	0.0
281	STAND STONE GRINDER	19660	90.7	92.6	85.7	87.5	5.0	5.4
388	SANDMULLER OPERATOR	854	90.5	90.5	87.7	87.7	2.8	2.8
402	ROTOBLAST OPERATOR	6835	90.4	93.5	90.1	93.3	0.3	0.2
440	SHAKEOUT OPERATOR	11967	90.3	93.0	84.3	84.9	6.0	8.1
327	INDUCT. FURNACE OPER	2563	90.2	94.5	89.3	94.2	0.9	0[illegible]
467	WHELLABRATOR OPER	8546	90.0	93.6	87.8	91.3	2.2	2[illegible]

ENVIRONMENTAL PROTECTION AGENCY

BBN JOB NO. 9635

EPA CRITERIA

TABLE 5-35 (Cont'd)

EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO. OF PERS.	SOUND LEVEL BEFORE MEAN	W.C.	AFTER MEAN	W.C.	CHANGE MEAN	W.C.
328	FURNACE CHARGER	854	89.9	92.6	88.6	92.0	1.3	0.7
367	POURER	18805	89.9	92.2	88.1	90.7	1.8	1.5
459	SHIFTER	2564	89.5	90.7	85.8	88.2	3.7	2.5
462	CUPOLA OPERATOR	854	89.4	93.4	88.4	93.0	1.1	0.4
368	MELTER/POURER	7693	89.4	93.8	89.1	93.7	0.4	0.1
427	CORE GLUER	854	89.4	90.5	88.3	89.6	1.1	0.8
429	OIL-BAKE COREMAKER	1709	88.6	88.6	88.5	88.5	0.1	0.1
329	CUPOLA FURNACE OPER	1709	88.4	93.0	88.4	93.0	0.0	0.0
480	OVERHEAD CRANE OPER	6836	88.4	88.4	88.0	88.0	0.3	0.3
385	MULLER OPER	4270	88.3	90.2	88.0	90.0	0.3	0.2
330	LADLE PRE-HEATER	5127	88.3	93.3	87.9	93.9	0.4	0.0
341	FLOOR MOLDER	17094	88.3	91.2	88.0	91.0	0.3	0.2
461	INSPECTOR	2563	88.2	89.0	81.2	83.0	7.0	6.1
202	FORKLIFT OPERATOR	6836	87.8	90.1	83.2	85.0	4.6	5.1
266	HELPER	5129	87.6	88.3	87.1	92.0	0.5	0.0
422	NO-BAKE CORE OPER	10256	87.3	89.2	87.1	89.0	0.2	0.3
270	FOREMAN	854	86.9	89.4	85.4	88.6	1.5	0.8
307	ACETYLENE WELDER	854	86.6	87.5	81.7	82.9	4.9	4.6
342	PACEMAKER MOLDR OPER	854	86.5	89.3	81.2	83.4	5.3	5.9
331	LADLE SKIMMER	3418	86.1	89.2	83.7	86.2	2.4	2.9
264	SERVICEMAN	23929	85.6	87.6	83.6	86.2	2.0	1.4
203	WORKSAVER OPERATOR	5129	84.8	86.4	79.9	79.9	4.9	6.5
433	CORE ROOM WORKER	20517	83.4	86.7	82.6	86.5	0.8	0.1
534	PRESS OPERATOR	5129	83.0	84.0	<75.0	76.9	8.0	7.1
265	LABORER	11110	82.6	84.5	81.6	84.8	1.0	0.0

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

TABLE 5-36
EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	SOUND LEVEL BEFORE MEAN	BEFORE W.C.	AFTER MEAN	AFTER W.C.	CHANGE MEAN	CHANGE W.C.
310	ARC AIR GOUGER	10255	103.5	107.4	93.5	97.3	10.0	10.0
450	DUMPOUT/SHAKEOUT OP	1709	103.5	103.5	95.5	95.5	8.0	8.0
318	GAS BURNER	1709	103.3	107.1	93.3	97.1	10.0	10.0
319	POWDER BURNER	1709	103.3	107.1	93.3	97.1	10.0	10.0
302	ARC-AIR OPERATOR	5129	101.4	105.3	91.4	95.3	10.0	10.0
282	TRIM GRINDER OPER	3419	98.3	98.3	98.3	98.3	0.0	0.0
504	RADIAL SAW OPERATOR	1709	98.3	98.3	98.3	98.3	0.0	0.0
326	ARC FURNACE OPERATOR	4274	98.0	101.9	98.0	101.9	0.0	0.0
443	SHAKEOUT TABLE OPER	5128	97.7	101.4	<90.0	93.4	7.7	8.0
343	MOLDMASTER OPERATOR	5129	96.9	98.7	92.5	94.3	4.5	4
505	CUT-OFF WHEEL OPER	7691	96.7	97.6	<90.0	<90.0	6.7	7.6
340	SQUEZ/JOLT MOLDER OP	29919	95.4	101.8	<90.0	91.9	5.4	9.9
277	PN DISC GRINDER OPER	3419	94.7	97.8	<90.0	<90.0	4.7	7.8
280	WHEEL GRINDER OPER	9403	94.6	101.0	<90.0	95.6	4.6	5.4
339	AUTO-MOLDER OPERATOR	3418	93.9	96.0	<90.0	<90.0	3.9	6.0
506	TABOR CUT-OFF SAW OP	1709	93.4	93.4	<90.0	<90.0	3.4	3.4
337	HI PRESS. MOLDER OP	1709	92.0	92.0	<90.0	<90.0	2.0	2.0
275	PN GRINDER OPER	70100	91.8	93.6	<90.0	<90.0	1.8	3.6
279	SWING GRINDER OPER	6837	91.5	92.0	<90.0	<90.0	1.5	2.0
426	CORE SETTER	2564	91.4	91.4	91.4	91.4	0.0	0.0
405	SPIRALBLAST OPERATOR	854	91.4	91.4	91.4	91.4	0.0	0.0
325	FURNACE OPERATOR	3419	91.3	91.3	91.3	91.3	0.0	0.0
276	PN DRILL GRINDER OP	854	91.0	93.6	<90.0	<90.0	1.0	3.6
395	SANDSLINGER OPERATOR	1709	91.0	94.9	<90.0	<90.0	1.0	4.9
421	SHELL CORE OPERATOR	16240	90.9	92.4	90.9	92.5	0.0	0.0
278	PN CONE GRINDER OPER	2564	90.4	92.6	<90.0	<90.0	0.4	2.6
502	BAND SAW OPERATOR	1709	90.3	90.3	90.3	90.3	0.0	0.0
403	HAND BLASTER	1709	90.0	90.0	90.0	90.0	0.0	0.0
404	MACHINE BLASTER	3419	<90.0	<90.0	<90.0	<90.0	0.0	0.0
281	STAND STONE GRINDER	19660	<90.0	91.6	<90.0	0.0	0.0	1.6
350	MOLD WASH WORKER	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
303	ARC WELDER/A	24790	<90.0	92.8	<90.0	82.6	0.0	2.8
338	SHELLMOLDER OPERATOR	3419	<90.0	91.2	<90.0	0.0	0.0	1.2
202	FORKLIFT OPERATOR	6836	<90.0	<90.0	<90.0	<90.0	0.0	0.0

ENVIRONMENTAL PROTECTION AGENCY BBN JOB NO. 9635

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

TABLE 5-36 (Cont'd)

EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE AVERAGES

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

JOB CODE	JOB DESCRIPTION	NO.OF PERS.	SOUND LEVEL BEFORE MEAN	SOUND LEVEL BEFORE W.C.	SOUND LEVEL AFTER MEAN	SOUND LEVEL AFTER W.C.	SOUND LEVEL CHANGE MEAN	SOUND LEVEL CHANGE W.C.
402	ROTOBLAST OPERATOR	6835	<90.0	92.0	<90.0	92.0	0.0	0.0
327	INDUCT. FURNACE OPER	2563	<90.0	92.8	<90.0	92.8	0.0	0.0
440	SHAKEOUT OPERATOR	11967	<90.0	91.0	<90.0	0.0	0.0	1.0
467	WHELLABRATOR OPER	8546	<90.0	92.4	<90.0	91.0	0.0	1.4
461	INSPECTOR	2563	<90.0	<90.0	<90.0	<90.0	0.0	0.0
368	MELTER/POURER	7693	<90.0	91.6	<90.0	91.6	0.0	0.0
385	MULLER OPER	4270	<90.0	<90.0	<90.0	<90.0	0.0	0.0
367	POURER	18805	<90.0	<90.0	<90.0	<90.0	0.0	0.0
330	LADLE PRE-HEATER	5127	<90.0	93.5	<90.0	93.3	0.0	0.2
422	NO-BAKE CORE OPER	10256	<90.0	<90.0	<90.0	<90.0	0.0	0.0
427	CORE GLUER	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
328	FURNACE CHARGER	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
341	FLOOR MOLDER	17094	<90.0	<90.0	<90.0	<90.0	0.0	0.0
388	SANDMULLER OPERATOR	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
264	SERVICEMAN	23929	<90.0	<90.0	<90.0	<90.0	0.0	0.0
429	OIL-BAKE COREMAKER	1709	<90.0	<90.0	<90.0	<90.0	0.0	0.0
459	SHIFTER	2564	<90.0	<90.0	<90.0	<90.0	0.0	0.0
265	LABORER	11110	<90.0	<90.0	<90.0	<90.0	0.0	0.0
203	WORKSAVER OPERATOR	5129	<90.0	<90.0	<90.0	<90.0	0.0	0.0
266	HELPER	5129	<90.0	<90.0	<90.0	<90.0	0.0	0.0
270	FOREMAN	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
307	ACETYLENE WELDER	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
329	CUPOLA FURNACE OPER	1709	<90.0	91.9	<90.0	91.9	0.0	0.0
331	LADLE SKIMMER	3418	<90.0	<90.0	<90.0	<90.0	0.0	0.0
342	PACEMAKER MOLDR OPER	854	<90.0	<90.0	<90.0	<90.0	0.0	0.0
433	CORE ROOM WORKER	20517	<90.0	<90.0	<90.0	<90.0	0.0	0.0
462	CUPOLA OPERATOR	854	<90.0	91.9	<90.0	91.9	0.0	0.0
480	OVERHEAD CRANE OPER	6836	<90.0	<90.0	<90.0	<90.0	0.0	0.0
534	PRESS OPERATOR	5129	<90.0	<90.0	<90.0	<90.0	0.0	0.0

TABLE 5-37

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             EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE

                            EPA CRITERIA

SIC CODE =  332           AVERAGE FOR INDUSTRY         NO DATES SPECIFIED

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                                             BEFORE CHANGE     AFTER CHANGE

TOTAL NO. OF PERSONNEL                           453958           453958
TOTAL NO OF PERS. WITH LEQ>75 (MEAN)             450538           445408
TOTAL NO OF PERS. WITH LEQ>75 (W.C.)             452248           452248
TOTAL NO OF PERS. WITH LEQ>90 (MEAN)             290659           108573
TOTAL NO OF PERS. WITH LEQ>90 (W.C.)             337690           206033
LEVEL WEIGHTED POPULATION (MEAN)              3553913.0        1679816.0
LEVEL WEIGHTED POPULATION (W.C.)              4667870.0        2709767.0

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ENVIRONMENTAL PROTECTION AGENCY                     BBN JOB NO.   9635



                          TABLE 5-38
           EFFECT OF NOISE CONTROL ON PERSONNEL EXPOSURE

                  THRESHOLD LEVEL        = 90.0 DBA
                  8-HR PERMISSIBLE LEVEL = 90.0 DBA
                  EXCHANGE RATE          =  5 DBA

SIC CODE =  332         AVERAGE FOR INDUSTRY        NO DATES SPECIFIED


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                                       BEFORE CHANGE     AFTER CHANGE

   TOTAL NUMBER OF PERSONNEL       =        453958          453958
   TOTAL NUMBER OVEREXPOSED (MEAN) =        210306           69247
   TOTAL NUMBER OVEREXPOSED (W.C.) =        286395          147044

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ENVIRONMENTAL PROTECTION AGENCY

BBN JOB NO. 9635

TABLE 5-39 EQUIPMENT NOISE IMPACT AVERAGES

EPA CRITERIA

AFTER NOISE CONTROL ON SELECTED EQUIPMENT

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LJ	W.C. LJ	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1103	PNEUMATIC GRINDER	44	85.6	88.2	******	72409.6	0.163
1434	FURNACE	19	91.6	96.0	646980	55596.7	0.125
1158	WELD/BURN/GOUGING	11	88.2	91.9	444470	42998.5	0.097
1448	CORE OVEN	9	93.9	95.3	240193	38354.7	0.086
1510	ELECTRIC GRINDERS	15	87.7	90.6	347886	34288.7	0.077
1333	MOLDER	28	87.8	93.6	542729	32074.6	0.072
1187	ABRASIVE BLASTING	8	93.1	96.5	76916	23657.2	0.053
1484	SHAKEOUT/DUMPOUT	16	89.6	93.0	405102	22656.0	0.051
1385	SANDSLINGER	2	98.0	98.0	60681	12615.1	0.028
1505	CUT-OFF WHEEL	6	90.7	92.8	219670	12204.5	0.027
1371	MULLER	13	92.6	98.1	219657	12167.6	0.027
1500	SAW/METAL	2	96.0	96.0	41019	10420.7	0.023
1497	WHEELABRATOR	5	90.2	95.8	112813	9127.4	0.020
1144	PNEUMATIC TAMPER	8	95.4	99.9	23077	9033.1	0.020
1460	LATHE	2	92.0	92.0	10255	5747.1	0.013
1444	CRUCIBLE	1	95.0	95.0	10256	5693.0	0.013
1480	PNEUMATIC VIBRATOR	4	100.2	103.3	86323	5084.9	0.011
1394	EXHAUST FAN	2	92.5	92.5	32481	3509.5	0.008
1457	CORE SET LINE	2	93.5	93.5	86320	3051.4	0.007
1135	PNEUMATIC CHISEL	4	103.8	112.8	5126	2034.0	0.005
1392	HYDRAULIC PUMP	1	96.0	96.0	1709	580.2	0.001
1525	HAMMERING	2	96.0	101.7	2562	512.6	0.001

ENVIRONMENTAL PROTECTION AGENCY

BBN JOB NO. 9635

TABLE 5-40 EQUIPMENT NOISE CONTROL PRIORITY AVERAGES

AFTER NOISE CONTROL ON SELECTED EQUIPMENT

THRESHOLD LEVEL = 90.0 DBA
8-HR PERMISSIBLE LEVEL = 90.0 DBA
EXCHANGE RATE = 5 DBA

SIC CODE = 332 AVERAGE FOR INDUSTRY NO DATES SPECIFIED

EQUIP. CODE	EQUIPMENT DESCRIPTION	NO.OF UNITS	MEAN LD	W.C. LD	NO.OF PERS.	PRIORITY INDEX	NORM. P.I.
1156	WELD/BURN/GOUGING	11	88.2	91.9	18802	18802.0	0.272
1448	CORE OVEN	9	93.9	95.3	7693	7693.0	0.111
1434	FURNACE	19	91.6	96.0	7693	7693.0	0.111
1500	SAW/METAL	2	98.0	98.0	6837	6837.0	0.099
1484	SHAKEOUT/DUMPOUT	16	89.6	93.0	8545	5537.0	0.080
1510	ELECTRIC GRINDERS	15	87.7	90.5	6838	5129.0	0.074
1371	MULLER	13	92.6	96.1	5129	3662.2	0.053
1444	CRUCIBLE	1	95.0	95.0	3419	3419.0	0.049
1457	CORE SET LINE	2	93.5	93.5	2564	2564.0	0.037
1187	ABRASIVE BLASTING	8	93.1	96.5	2563	2563.0	0.037
1505	CUT-OFF WHEEL	6	90.7	92.8	1709	1709.0	0.025
1135	PNEUMATIC CHISEL	4	103.6	112.8	1709	1709.0	0.025
1333	MOLDER	28	87.8	93.6	5129	1466.8	0.021
1497	WHEELABRATOR	5	90.2	95.8	854	445.0	0.006

Section 6

EXPECTED ERRORS IN PERSONNEL NOISE EXPOSURE AND IMPACT PREDICTIONS

6.1 Introduction

The important industry averaged parameters predicted by the BBN computer program are as follows:

1. Total Level Weighted Population (LWP) for the industry and for each plant
2. Total Population with an 8-hour $L_{eq}(8)>75$ dBA, where $L_{eq}(8)$ is calculated using the EPA formulation discussed in Section 5
3. Total Population with an 8-hour $L_{eq}(8) >90$ dBA, where $L_{eq}(8)$ is calculated using the OSHA formulation
4. Total population with an 8-hour $L_{eq}(8) >90$ dBA, where $L_{eq}(8)$ is calculated using the OSHA formulation outlined in Section 5
5. Total LWP for individual personnel categories (EPA criteria)
6. Daily Noise Dose (DND) for individual personnel categories (OSHA criteria)
7. Equipment impact normalized priority index (NPI) for individual equipment classifications (EPA criteria)
8. Equipment impact normalized priority index (NPI) for individual equipment classifications (OSHA criteria).

The first six parameters are predicted in terms of a mean and worst case. The mean value predictions are based on data collected in the field and the worst case predictions are calculated from the mean, using as a basis the variance in the field data, as outlined in Section 5.

The issue of interest here is the expected error in the parameter estimates for an entire industry based upon the sample measurements used for the parameter calculations. Specifically, it is desired to establish (a) confidence limits about the parameter estimates which define the accuracy of the predicted industry averages, (b) tolerance (prediction) limits about the parameter estimates which define the range of parameter values to be expected for individual plants not included in the sample, and, (c) verification of the validity of the worst case estimates for the first six parameters. To accomplish such error evaluations, it is necessary to assume that the sample plants used to calculate the parameter estimates for the industry represent a random selection of typical plants within that industry.

The theoretical basis used to derive the results presented in the following sections is outlined in Appendix A.

6.2 Applications to Sawmill Industry Data

The sample of the sawmill industry noise exposure levels produced data for $n = 9$ mills which are believed to be representative of the industry.

6.2.1 Total LWP Values for Sawmill Industry (Parameter 1)

The computer analysis described earlier in this report gives Level Weighted Population (LWP) results in terms of a mean and worst case estimate. The mean is the actual value calculated from the measured data and the worst case is an estimate, based on the variance of the data, of the highest likely value.

The LWP values for the nine sample mills and the overall sample values are summarized in Table 6-1. Substsituting appropriate results from this table into Eq.(A-4) yields the 90% confidence intervals for the predicted LWP value for the entire industry. The interpretation of these confidence intervals is straightforward. Given the mean predicted LWP value of 1,078,540, for the industry based upon measurements in n = 9 randomly selected plants, it can be said with 90% confidence that the true LWP value for the industry is between 891,465 and 1,265,540, or within about ± 17% of the predicted value. The worst case LWP prediction is 1,625,903. which as expected is larger than the upper value of the 90% confidence interval for the mean and indicates that it is indeed a worst case prediction which is unlikely to be exceeded.

To look at the plants on an individual basis, it is necessary to normalize the total LWP for a given plant by dividing the plant population.

Tolerance (prediction) intervals for the normalized LWP values of individual plants within the industry, computed using the nonparametric relationship of Eq.(A-5), are given in Table 6-2. From these results, it can be stated with 90% confidence that at least 63% of all plants will have a normalized LWP value between 3.824 and 7.938. These same limits apply to at least 75% of all plants with 70% confidence, and at least 82% of all plants with 50% confidence. The worst case estimate of 7.017 is close to the upper 90% confidence limit and thus is a reasonable estimate of the highest likely value for the normalized LWP for the entire industry. As stated in Section 3 the worst case results for the individual plant analyses should be ignored.

Table 6-1 Level Weighted Population Exposure Data for the Sawmill Industry

Plant Number	Number of Personnel (m_i)	LWP(y_i)		Normalized LWP(x_i)	
		Mean	Worst Case	Mean	Worst Case
1	201	768.6		3.824	
2	119	561.5		4.718	
3	95	667.7		7.028	
4	43	205.6		4.781	
5	43	227.9		5.300	
6	88	407.5		4.631	
7	179	780.8		4.362	
8	78	619.2		7.938	
9	58	226.9		3.912	
All 9	904	4208.0	6343.6	4.655	7.017
s	-	-	-	1.302	
Industry	231700	1078540	1625903	4.655	7.017

Table 6-2. Prediction Limits for Normalized Mean LWP Values of Individual Sawmills

Confidence Coefficient	Portion of Mills Within Interval	Predicted Normalized LWP Value	Predicted Worst Case Value	Interv. Limits Lower	Interv. Limits Upper
0.90	0.63	4.655	7.017	3.824	7.938
0.70	0.75				
0.50	0.82				

6.2.2 FOP Values for Sawmill Industry (Parameters 2,3,and 4).

The fraction of personnel (FOP) exposed to an 8 hours L_{eq} > 75 dBA and $L_{eq}(8)$ > 90 dBA for each of the nine sample plants, and the overall FOP for all 9 sample plants are summarized in Table 6-3. Substituting appropriate results from this table into Eq. (A-8) gives the 90% confidence intervals shown in Table 6-4 for the predictions. From these results, it can be said with 90% confidence that the true fraction of personnel in the industry with an exposure of $L_{eq}(8)$ > 75 dBA is 0.88 to 0.93. The worst case prediction of 0.917 is slightly less than the upper 90% confidence limit but is a reasonable estimate of the highest likely value. The intervals for L_{eq} > 90 dBA (EPA criteria) are 0.19 to 0.36. The intervals for $L_{eq}(8)$ > 90 dBA (OSHA criteria) are 0.17 to 0.33. The worst case prediction of 0.399 is again a good estimate of the upper limit which is unlikely to be exceeded.

Table 6-3 Number of Critically Exposed Personnel Data for Sawmill Industry

Plant Number	Number of Personnel (m_i)	Portion Exposed To $L_{eq}(8)>75$ dBA		Portion Exposed To $L_{eq}(8)>90$ dBA (EPA criterion)		Portion Exposed To $L_{eq}(8)>90$ dBA (OSHA criterion)	
		Mean	Worst Case	Mean	Worst Case	Mean	Worst Case
1	201	0.876		0.264		0.184	
2	119	0.941		0.445		0.336	
3	95	0.937		0.516		0.474	
4	43	0.837		0.581		0.419	
5	43	0.977		0.372		0.349	
6	88	0.920		0.341		0.341	
7	179	0.866		0.112		0.101	
8	78	0.897		0.385		0.385	
9	58	0.845		0.345		0.276	
All 9	904	0.900	0.917	0.275	0.576	0.249	0.399
s	-	0.0376	-	-	-	0.123	-
Industry	231700	0.900	0.917	0.279	0.576	0.249	0.399

Table 6-4 90% Confidence Limits for Sawmill Industry FOP Values

Case	Mean FOP Value	Predicted Worst Case Value	90% Interval Limits	
			Lower	Upper
$L_{eq}(8) > 75$ dBA	0.900	0.917	0.88	0.93
$L_{eq}(8) > 90$ dBA EPA Criteria	0.279	0.576	0.19	0.36
$L_{eq}(8) > 90$ dBA OSHA Criteria	0.249	0.399	0.17	0.33

As expected, the FOP with $L_{eq}(8)$ > 90 dBA is greater when EPA criteria are used as noise levels between 75 dBA and 90 dBA are included in the $L_{eq}(8)$ calculation whereas these levels excluded in the OSHA calculation. The worst case prediction of 0.576 is well above the upper 90% confidence limit, indicating that it is indeed an upper level estimate which is unlikely to be exceeded. The intervals discussed in the preceding text can be converted to actual numbers of personnel by multiplying the fractional portions by 231,700 - the estimated number of personnel in the industry.

Tolerance (prediction) limits on the FOP values for individual plants in the industry are detailed in Table 6-5. As before, the limits can be assumed to include various different portions of all sawmills with the noted confidence coefficient. For example, it can be stated with 90% confidence that at least 63% of the mills in the industry will have FOP values between 0.84 and 0.98 for exposures of $L_{eq}(8)$ > 75 dBA, and between 0.11 and 0.58 for exposures of $l_{eq}(8)$ > 90 dBA.

6.2.3 Level Weighted Population Values for Individual Personnel Categories

The level weighted population (LWP) values for various personnel categories in the entire industry are summarized in Table 6-6. Only the most important 21 personnel categories are included. The estimated category population for the entire industry (Column 2) was derived from the category population for the nine plants sampled and the ratio of total industry population to total population in the nine sample plants. These estimates could be improved at a later date by sending out questionnaires to a large percentage of plants in the industry, as discussed later in this report.

Table 6-5 Prediction Limits for FOP Values of Individual Sawmills

Case	Confidence Coefficient	Portion of Plants Within Interval	Predicted Mean FOP Value	Interval Limits for mean values	
				Smallest value in Sample	Largest value in Sample
$L_{eq}(8)$ >75 dBA mean	0.90 0.70 0.50	0.63 0.75 0.82	0.900	0.84	0.98
$L_{eq}(8)$ >90 dBA EPA Criterion	0.90 0.70 0.50	0.63 0.75 0.82	0.279	0.11	0.58
$L_{eq}(8)$ >90 dBA OSHA Criterion	0.90 0.70 0.50	0.63 0.75 0.82	0.249	0.10	0.47

Table 6-6 90% Confidence Limits for Sawmill Industry LWP Values (EPA Criteria)

Job Code	Est. Categ. Population	Job Description	LWP (Indust. Average)		Worst Case Prediction	Sample Standard Deviation (Norm. LWP)	LWP Confidence Limits (90%)	
			Prediction	Normalized			Lower	Upper
173	13837	Grader/Planer Mill	92323	6.672	121382	3.106	66044	118569
211	14095	Millwright/General	86567	6.142	111593	3.335	57832	115283
168	3329	Planer Set-Up Man	79853	23.987	100769	11.820	55731	103815
167	7175	Planer Operator	78610	10.956	111853	5.932	52600	104604
176	23321	Dry Chain Puller	62407	2.676	100916	1.416	42211	82556
228	10506	Electricians	59679	5.680	75452	3.203	39124	80224
148	9479	Trimmer Operator	49056	5.175	93561	3.991	25906	72145
151	7430	Green Chain Puller	43544	5.861	61372	3.137	29274	57761
202	14607	Forklift Operator	41980	2.874	75054	1.646	27286	56675
134	6407	Edger Operator	36306	5.666	86772	4.480	18766	53838
137	2304	Chipper Operator	33812	14.675	45672	7.361	23402	44129
212	3843	Millwright/Sawmill	28839	7.504	31331	3.375	20910	36758
101	3328	Sawmill Supervisor	23122	6.947	25305	3.578	15821	30371
154	7174	Stacker - Green	20841	2.905	50144	1.014	16371	25267
127	1793	Tail Sawyer	20058	11.189	32880	5.412	14123	25982
213	1792	Millwright/Planer	20005	11.164	25783	5.958	13449	26495
140	3075	Resaw Operator	18887	6.142	23680	3.736	11860	25901
144	1792	Lumber Diverter	17226	9.612	21006	3.842	12988	21400
261	2560	Clean-Up Man/Regular	16617	6.491	20817	4.249	9948	23240
138	1536	Hog Operator	15862	10.327	20126	5.199	10973	20733
104	2561	Planer Supervisor	15828	6.180	18367	3.484	10359	21264

The statistical results shown in Table 6-6 were derived on the assumption that the values in column 2 of the table are good estimates of the true values.

Table 6-6 shows that the predicted worst case values are generally close to the upper 90% confidence limit, indicating that they are reasonable estimates of the highest likely values. (Compare columns 5 and 7 in the table). From Table 6-6, it can be seen that although the Grader/Planer Mill category has the highest predicted LWP value for the entire industry, the sampling errors are such that six other personnel categories could feasibly have a higher LWP value for the industry as a whole. This follows because the upper bounds on the LWP values for six other personnel categories are higher than the lower bound for the Grader/Planer Mill category.

6.2.4 Daily Noise Dose

The OSHA criteria involve a Daily Noise Dose (DND) calculation for the various labor categories which is directly related to the eight hour equivalent noise level exposure ($L_{eq}(8)$). Specifically,

$$DND = 10^{[(L_{eq}(8)-90)/16\cdot 65)]} \qquad (6\text{-}1)$$

Hence, the variability of the DND data is directly related to the variability of the $L_{eq}(8)$ calculations.

The DND values for various personnel categories in the 9-plant sample are summarized in Table 6-7. Only the most important 15 categories are included. The table shows that the variance is similar to the LWP values and that for an industry average any one of 5 personnel categories could conceivably be the most important. The table also shows that the worst case predictons are generally good estimates of the likely upper limit of the

Table 6.7 90% Confidence Limits for Sawmill Industry DND Values Using OSHA Criteria

Code	Description	Daily Noise Dose	Sample Standard Deviation	DND Worst Case Prediction	Confidence Limits	
					Lower	Upper
168	Planer Set-up Man	7.45	6.77	12.29	3.29	11.64
137	Chipper Operator	3.00	1.61	4.94	2.00	4.00
128	Quadsaw Tail Sawyer	2.64	0.893	2.64	2.09	3.19
127	Tail Sawyer	2,46	1.30	5.71	1.65	3.27
167	Planer Operator	2.02	2.16	3.38	0.68	3.36
144	Lumber Diverter	1.79	0.756	2.38	1.32	2.26
185	Ripsaw Operator	1.74	0.589	1.74	1.37	2.10
138	Hog Operator	1.71	0.860	2.46	1.17	2.23
213	Millwright/Planer	1.44	0.599	2.28	1.07	1.81
133	Slab Board Puller	1.41	0.477	1.56	1.11	1.71
186	Ripsaw Offbearer	1.32	0.447	1.32	1.04	1.69
212	Millwright/Sawmill	1.17	0.574	1.28	0.81	1.53
173	Grader/Planer Mill	1.15	0.797	1.56	0.66	1.64
245	Oiler	1.15	0.586	1.36	0.79	1.51
191	Specialty Resaw Offb.	1.11	0.782	2.39	0.62	1.60

industry average DND values for each personnel category (compare columns 5 and 7 in the table).

6.2.5 NPI Values for Sawmill Industry

The normalized priority index (NPI) values (calculated using EPA criteria) for various types of equipment in the nine sample mills, and the standard deviations of the NPI values for individual plants are summarized in Table 6-8. The data cover all types of machines which had an NPI value in excess of 1% (NPI > 0.01). 90% confidence limits on the true NPI value for each type of equipment calculated using Eq. (A-16) are also shown in this table.

From Table 6-8, it can be seen that although the Planers have the highest predicted NPI value, the sampling errors are such that four other types of equipment could feasibly have a higher NPI value for the industry as a whole, namely, Kiln Chains, Headrigs, Dry Chains, and Green Chains. This follows because the upper bounds on the NPI values for these four equipment types are higher than the lower bound on the NPI value for the Planers. Of course, the probability that this might be true is very small. However, for the equipment types with predicted NPI values of less than, say 5%, their order of importance could easily be quite different than indicated by the predicted NPI values because the confidence intervals strongly overlap.

Similar NPI results calculated using OSHA criteria are summarized in Table 6-9. Comparing the results in this table with those in Table 6-8, it it clear that the variability in the NPI values using EPA and OSHA criteria is similar; i.e., the statistical stability of the OSHA results is no better than for the EPA results. This matter is pursued further in Section 6.4.

table 5.8

Table 6-8 90% Confidence Limits for Sawmill Industry
NPI Values - EPA Criteria

Equip. Code	Equipment Description	Normal Priority Index	Sample Standard Deviation	Confidence Limits	
				Lower	Upper
1699	Planer	0.167	0.080	0.118	0.216
1688	Kiln Chain	0.131	0.072	0.087	0.175
1620	Headrig	0.109	0.088	0.055	0.163
1739	Dry Chain	0.086	0.053	0.053	0.119
1800	Forklift	0.079	0.028	0.062	0.096
1664	Trimmer	0.073	0.029	0.055	0.091
1629	Edger	0.069	0.039	0.045	0.093
1679	Green Chain	0.066	0.101	0.004	0.128
1644	Resaw/Large	0.029	0.028	0.012	0.046
1810	Lumber Carrier	0.025	0.023	0.011	0.039
1792	Powerhouse	0.022	0.027	0.005	0.039
1600	Debarker	0.020	0.023	0.006	0.034
1819	Quadsaw	0.016	0.040	0	0.041
1828	Gang Saw	0.016	0.036	0	0.038
1759	Resaw/Specialty	0.016	0.028	0	0.033
1779	Chipper	0.015	0.010	0.009	0.021
1776	Conveyor/Gen.	0.013	0.018	0.002	0.024

Table 6-9 90% Confidence Limits for Sawmill Industry NPI Values using OSHA Criteria

Equip. Code	Equipment Description	Normal Priority Index	Sample Standard Deviation	Confidence Limits	
				Lower	Upper
1699	Planer	0.396	0.260	0.236	0.556
1629	Edger	0.119	0.091	0.063	0.175
1620	Headrig	0.104	0.066	0.063	0.145
1644	Resaw/Large	0.084	0.075	0.038	0.130
1679	Green Chain	0.082	0.171	0	0.187
1664	Trimmer	0.054	0.071	0.010	0.098
1779	Chipper	0.045	0.040	0.020	0.070
1828	Gang Saw	0.025	0.051	0	0.056
1819	Quadsaw	0.025	0.055	0	0.059
1785	Hog	0.023	0.028	0.006	0.040
1759	Resaw/Specialty	0.022	0.041	0	0.047

6.3 Applications to Foundry Industry Data

The sample of the foundry industry noise exposure levels produced data for n = 7 foundries which are believed to be representative of the industry.

6.3.1 Total LWP Values for Foundry Industry (Parameter 1)

The level weighted population (LWP) values for the seven sample foundries are summarized in Table 6-10. Using the results of Table 6-10 and given the mean predicted LWP value of 3,553,913 for the industry based upon measurements in n = 7 randomly selected plants, it can be stated with 90% confidence that the true LWP value for the industry is between 3,175,040 and 3,933,140 or within ± 11% of the predicted value. The worst case LWP prediction is 4,687,870 which is larger than the upper value of the 90% confidence interval for the mean and is a good indication of the upper limit which is unlikely to be exceeded.

Tolerance (prediction) intervals for the normalized LWP values of individual foundries within the industry, computed using the nonparametric relationship of Eq. (A-5), are presented in Table 6-11. For the sample size of n = 7, the stated limits apply to at least 55% of the foundries with 90% confidence, at least 69% with 70% confidence, and at least 77% with 50% confidence.

6.3.2 FOP Values for Foundry Industry (Parameters 2, 3 and 4)

The fraction of personnel (FOP) exposed to $L_{eq}(8) > 75$ dBA and $L_{eq}(8) > 90$ dBA for each of the seven sample foundries, and the overall FOP value for all seven sample foundries are summarized in Table 6-12. The 90% confidence intervals computed from Eq (A-8) are shown in Table 6-13. From these results, it is seen that the fractional portion of personnel in the foundry

Table 6-10 Level Weighted Population Exposure Data for the Foundry Industry

Plant Number	Number of Personnel (m_i)	LWP(y_i)		Normalized LWP(x_i)	
		Mean	Worst Case	Mean	Worst Case
1	44	419.0		9.523	
2	48	399.5		8.323	
3	70	524.7		7.496	
4	46	380.6		8.274	
5	248	1988.5		8.025	
6	23	75.0		3.261	
7	52	361.0		6.942	
All 7	531	4160.6	5483.5	7.835	10.326
s	-	-	-	1.137	
Industry	453958	3556913	4687870	7.835	10.326

Table 6-11 Prediction Limits for Normalized LWP Values of Individual Foundries

Case	Confidence	Portion of Foundries Within Interval	Predicted Normalized LWP Value	Interval Limits Lower	Interval Limits Upper
Mean	0.90	0.55	7.835	3.260	9.522
	0.70	0.69			
	0.50	0.77			

Table 6-12 Number of Critical Personnel Data for Foundry Industry

Foundry Number	Number of Personnel (m_i)	Portion Exposed To $L_{eq}(8)>75$ dBA		Portion Exposed To $L_{eq}(8)>90$ dBA (EPA criteria)		Portion Exposed To $L_{eq}(8)>90$ dBA (OSHA criteria)	
		Mean	Worst Case	Mean	Worst Case	Mean	Worst Case
1	44	1.000		0.977		0.886	
2	48	1.000		0.854		0.542	
3	70	1.000		0.671		0.457	
4	46	1.000		0.652		0.630	
5	248	0.992		0.605		0.532	
6	23	0.957		0.130		0.130	
7	52	1.000		0.519		0.346	
All 7	531	0.992	0.996	0.640	0.744	0.463	0.631
s	-	0.00888		0.164		0.150	
Industry	453958	0.992	0.996	0.640	0.744	0.463	0.631

Table 6-13. 90% Confidence Limits for Foundry Industry FOP Values

Case	Predicted FOP Value	Interval Limits		Worst Case Value
		Lower	Upper	
$L_{eq}(8)>75$ dBA, Mean	0.992	0.985	0.999	0.996
$L_{eq}(8)>90$ dBA (EPA criteria)	0.640	0.520	0.760	0.744
$L_{eq}(8)>90$ dBA (OSHA criteria)	0.463	0.353	0.573	0.631

industry that will be exposed to $L_{eq}(8) > 75$ dBA is at least 98%. For an exposure of $L_{eq}(8) > 90$ dBA, the fractional portion is 52 to 76% for EPA criteria, and 35 to 57% for OSHA criteria. Again, the worst case prediction is seen to be a good estimate of the likely upper limit to the values.

Tolerance (prediction) limits on the FOP values for the individual industries are shown in Table 6-14. As before, the limits can be assumed to include various different portions of all foundries with the noted confidence coefficient. For example, using the mean data, it can be said with 90% confidence that at least 55% of the individual foundries in the industry will have FOP values between 0.96 and 1.00 for exposures of $L_{eq}(8) > 75$ dB, and between 0.13 and 0.98 for exposures of $L_{eq}(8) > 90$ dBA.

Table 6-14 Prediction Limits for FOP Values of Individual Foundries

Case	Confidence Coefficient	Portion of Foundries Within Interval	Predicted Mean FOP Value	Interval Limits for Mean Values	
				Smallest Value in Sample	Largest Value in Sample
$L_{eq}(8)>75$ dBA, Mean	0.90 0.70 0.50	0.55 0.69 0.77	0.992	0.96	1.00
$L_{eq}(8)>90$ dBA (EPA criteria)	0.90 0.70 0.50	0.55 0.69 0.77	0.640	0.13	0.98
$L_{eq}(8)>90$ dBA (OSHA criteria)	0.90 0.70 0.50	0.55 0.69 0.77	0.463	0.13	0.89

6.3.3 Level Weighted Population Values for Individual Personnel Categories

The LWP values for the most important 19 personnel categories in the foundry industry are summarized in Table 6-15. The category with the largest predicted LWP is pneumatic grinder operator. Only the squeeze jolt-molder category could feasibly have a higher LWP due to sampling errors. Again the worst case prediction values are close to the upper limit of the 90% confidence interval for most categories, indicating that the worst case is a good prediction of the likely upper limit for the LWP values in each category.

6.3.4 Daily Noise Dose

The DND values for various personnel categories in the seven plant sample are summarized in Table 6-16. Again the variance in these values is similar to the variance in LWP values.

6.3.5 NPI Values for Foundry Industry

The normalized priority index (NPI) values for various types of equipment in the seven sample foundries, and the standard deviations of the NPI values for the individual foundries computed using Eq. (A-15) are summarized in Table 6-17. As before, the data cover all types of equipment which had an NPI value in excess of 1% (NPI > 0.01). 90% confidence limits on the True NPI value for each type of equipment calculated using Eq.(A-16) are also shown in this table.

Similar NPI results calculated using OSHA criteria are summarized in Table 6-18. Again it is clear that the variability in NPI values using OSHA criteria and EPA criteria is similar. This matter is pursued further in the next section.

Table 6.15 **90% Confidence Limits for Foundry Industry LWP Values (EPA Criteria)**

Job Code	Est. Categ. Population	Job Description	LWP-Industry Average		Worst Case Prediction	Sample Standard Deviation for Normalized LWP	LWP Confidence Limits (90%)	
			Industry Average	Normalized			Lower	Upper
275	70100	PN Grinder Operator	626773	8.941	768070	3.733	439527	814281
340	29919	Squz/Jolt Molder Op.	348776	11.657	569463	4.412	254102	443130
303	24790	Arc Welder/A	235939	9.518	318564	5.464	139047	333004
310	10255	Arc Air Gouger	225570	21.996	287184	11.653	139960	311095
421	16240	Shell Core Operator	127559	7.855	147676	2.254	89905	153368
281	19660	Stand Stone Grinder	121862	6.198	156074	2.254	89905	153368
367	18895	Pourer	110720	5.888	146650	4.507	50059	171426
302	5129	Arc Air Operator	103976	20.272	133500	4.911	85916	121983
505	7691	Cut Off Wheel Operator	103976	13.134	111418	5.741	78717	132808
280	9403	Wheel Grinder Operator	97905	10.412	170481	4.091	70504	125586
341	17094	Floor Molder	80723	4.722	117619	4.150	30000	131573
443	5128	Shakeout Table Operator	73921	14.415	99111	7.419	46737	101216
264	23929	Serviceman	73735	3.081	101293	1.641	45393	101626
440	11967	Shakeout Operator	69730	5.827	97488	1.999	52774	87024
343	5129	Moldmaster Operator	68540	13.363	80649	6.667	44058	93030
326	4274	Arc Furnace Operator	61252	14.331	82457	6.865	40270	82283
279	6837	Swing Grinder Operator	53331	7.800	56629	3.465	36134	70059
282	3419	Trim Grinder Operator	52984	15.497	52984	4.378	42385	63822
467	8546	Wheelabrator Operator	49576	5.801	75573	3.908	25553	73376

Table 6.16 90% Confidence Limits for Foundry Industry DND Values Using OSHA Criteria

Code	Job Description	Daily Noise Dose	Sample Standard Deviation	DND Worst Case Prediction	Confidence Limits	
					Lower	Upper
310	Arc Air Gouger	6.54	3.80	11.09	3.75	9.33
450	Dumpout/Shakeout Operator	6.52	1.69	6.52	5.28	7.76
318	Gas Burner	6.34	3.80	10.77	3.55	9.13
302	Arc-Air Operator	4.88	0.894	8.28	4.22	5.54
282	Trim Grinder Operator	3.17	0.912	3.17	2.50	3.84
504	Radial Saw Operator	3.17	0.910	3.17	2.50	3.84
326	Arc Furnace Operator	3.02	1.54	5.18	1.89	4.15
443	Shakeout Table Operator	2.91	1.68	4.84	1.68	4.14
343	Moldmaster Operator	2.61	1.30	3.32	1.66	3.56
505	Cut-off Wheel Operator	2.52	1.28	2.96	1.58	3.46
340	Squez/Jolt Molder Operator	2.11	0.750	5.14	1.56	2.66
277	Pn. Disc Grinder Operator	1.92	0.514	2.93	1.54	2.30
280	Wheel Grinder Operator	1.89	0.755	4.61	1.34	2.44
339	Auto-Molder Operator	1.71	0.677	2.30	1.21	2.21

Table 6-17 90% Confidence Limits for Foundry Industry NPI Values - EPA Criteria

Code	Job Description	Normal Priority Index	Sample Standard Deviation	Confidence Limits	
				Lower	Upper
1103	Pneumatic Grinder	0.196	0.108	0.117	0.275
1158	Weld/Burn/Gouging	0.112	0.094	0.043	0.181
1333	Molder	0.100	0.097	0.029	0.171
1434	Furnace	0.097	0.070	0.046	0.148
1484	Shakeout/Dumpout	0.087	0.038	0.059	0.115
1448	Core Oven	0.081	0.113	0.015	0.179
1510	Electric Grinder	0.076	0.032	0.053	0.099
1187	Abrasive Blasting	0.042	0.033	0.018	0.066
1505	Cut-off Wheel	0.030	0.018	0.017	0.043
1385	Sandslinger	0.024	0.022	0.008	0.040
1500	Saw/Metal	0.020	0.065	0	0.067
1144	Pneumatic Tamper	0.017	0.020	0.002	0.032
1497	Wheelabrator	0.017	0.011	0.009	0.025
1371	Muller	0.016	0.014	0.006	0.026
1460	Lathe	0.012	0.012	0.003	0.021
1444	Crucible	0.011	0.036	0	0.037

Table 6.18 90% Confidence Limits for Foundry Industry NPI Values Using OSHA Criteria

Code	Job Description	Normal Priority Index	Sample Standard Deviation	Confidence Limits	
				Lower	Upper
1103	Pneumatic Grinder	0.380	0.237	0.206	0.554
1333	Molder	0.140	0.128	0.046	0.234
1158	Weld/Burn/Gouging	0.130	0.112	0.048	0.212
1510	Electric Grinders	0.076	0.112	0.048	0.212
1484	Shakeout/Dumpout	0.059	0.067	0.010	0.108
1505	Cut-off Wheel	0.045	0.046	0.011	0.079
1434	Furnace	0.037	0.070	0	0088
1448	Core Oven	0.037	0.090	0	0.103
1500	Saw/Metal	0.033	0.088	0	0.098
1444	Crucible	0.016	0.044	0	0.048
1457	Core Set Line	0.012	0.033	0	0.036
1187	Abrasive Blasting	0.012	0.014	0.002	0.022
1371	Muller	0.009	0.010	0.002	0.016
1135	Pneumatic Chisel	0.008	0.007	0.002	0.014
1385	Sandslinger	0.003	0.003	0.001	0.005

From Table 6-17, it can be seen that the Pneumatic Grinder has the highest average NPI value, but any one of the next five equipment items in the order (through Core Ovens) could actually be more important since the upper bound on their confidence intervals is higher than the lower bound for the Pneumatic Grinder. Similarly, the last eight equipment items could in reality have a significantly different order of importance since their confidence limits strongly overlap.

In summary, for this sample of seven foundries, the normalized priority index calculation appears to provide only a coarse estimate of the importance of various machines to the noise exposure of workers.

6.4 Sample Size Requirements

In this section we determine the number of plants which need to be sampled from each of the sawmill and foundry industries in order to obtain good estimates of values for Level Weighted Population, Daily Noise Dose and Equipment Normalized Priority Index.

The total Level Weighted Population (LWP) data for the entire industry (parameter 1) are reasonably stable even for the sample sizes of 9 and 7 plants involved in the sawmill and foundry industry studies. The Normalized Priority Index (NPI) Daily Noise Dose (DND) results, and LWP results for individual personnel categories however, are rather unstable due to the large standard deviation in the values from one plant to the next. One way of assessing this standard deviation is in terms of a "coefficient of variation" ε given by

$$\varepsilon = s/x \qquad (6-2)$$

where s = standard deviation of the sample values from one plant to the next.

x = mean value for all plants in the sample.

The average coefficients of variation for the LWP, NPI and DND values for the sawmill and foundry industries are summarized in Table 6-19. Note that the coefficient of variation for the total industry LWP as well as the individual personnel category LWP is shown. As expected the variation for the total industry LWP is less than the variation for individual personnel categories.

Table 6-19 Average Coefficients of Variation for NPI and DND Values for Sawmill and Foundry Industries

Industry	No. of Plants	Average Coefficient of Variation				
		EPA-NPI	EPA-LWP	EPA-Tot.LWP	OSHA-NPI	OSHA-DND
Sawmill	9	1.22	0.55	0.28	1.49	0.58
Foundry	7	1.46	0.51	0.15	1.66	0.44

The values in this table represent an energy average; i.e.,

$$\varepsilon_{av} = \left[\frac{1}{n} \sum_{i=1}^{n} \varepsilon_i^2\right]^{\frac{1}{2}} \tag{3}$$

It is seen from Table 6-19 that the variability of the NPI values for both industries using either the EPA or OSHA criteria are similar. The average 90% confidence limits here can be approximated by

$$90\%\ \text{C.L.} = x(1 \pm 1.7\ \varepsilon/\sqrt{n}) \tag{4}$$

where the 1.7 factor represents the approximate value of the Student "t" variable for a relatively large sample size (n>15).

From the preceding expression the sample size required to obtain a given accuracy with 90% confidence can be estimated. Sample size estimates for an accuracy of ±50% and ±20% are given in Tables 6-20 and 6-21 below. The tables indicate how many plants need to be sampled in a particular industry to result in the indicated accuracy (±20%, ±50%) for estimates of the quantities shown.

Table 6-20 Minimum Number of Plants to be Sampled for ±50% error with 90% Confidence

Industry	EPA-NPI	EPA-LWP	EPA-Tot LWP	OSHA-NPI	OSHA-DND
Sawmill	18	6	<5	26	6
Foundry	25	5	<5	32	<5

Table 6-21 Minimum Number of Plants to be Sampled for ±20% error with 90% Confidence

Industry	EPA-NPI	EPA-LWP	EPA-Tot LWP	OSHA-NPI	OSHA-DND
Sawmill	100	22	7	150	25
Foundry	150	20	<5	190	15

The preceding tables show that sufficient plants were sampled in the survey reported here to give a good estimate of the total Level Weighted Population (LWP) for each industry. The tables also show that relatively few plants need to be sampled in each industry in order to rank the importance of a given industry in terms of overall personnel noise exposure. However, the error in the estimates for the industry averaged LWP and Daily Noise Dose (DND) for individual personnel categories, is probably on the order of ±50%. For ±20% accuracy in these quantities (with 90% confidence), approximately 25 plants would have to be sampled in each industry. For a ±20% accuracy in the industry averaged Normalized Priority Index (NPI) values for various equipment classifications, the results show that between 100 and 190 plants would need to be sampled.

However, as mentioned earlier, the results obtained with the limited sample size used herein are useful in that they indicate which classifications of equipment are the most important contributors to the LWP and DND values in each industry, although the ordering shown may change slightly if a larger plant sample were used.

Section 7
RECOMMENDATIONS FOR FUTURE WORK

This section contains details of the work which we consider is necessary to complete the project which we have begun here. Each recommendation is discussed in detail below.

7.1 Determination of Minimum Noise Reduction Requirements

This work involves the use of an iterative procedure to determine the Minimum Equipment noise reductions necessary to achieve compliance with a given criteria, be it EPA or OSHA. The method involves the following steps:

(a) reduce the noise level of the equipment with the highest priority index by 1 dB (or less if more accuracy is desired);

(b) Recalculate the personnel exposure impact and the equipment priority indices;

(c) Repeat the above two steps until all personnel are in compliance with the criteria.

Complications in this procedure which need to be considered are as follows:

(a) Suitable consideration of background noise levels and the calculation of the effect on a given background level of noise reduction for one or more equipment types contributing to it;

(b) Allowance for the exclusion from the iteration process of equipment types for which noise control is considered not practical or not feasible;

(c) Use of an "ease of treatment" index to further weight the iterative procedure towards equipment types which are easier to treat.

7.2 Economic Evaluation

This work involves the determination of the cost to industry, of compliance with a given personnel noise exposure criteria (EPA or OSHA). The cost determination is closely linked with the determination of the minimum noise reduction requirements as discussed in the previous section. In addition the following information would be required.

(a) Estimation of the number of each type of equipment in the particular industry. This could be obtained using a questionaire sent to a large proportion of plants involved in the industry;

(b) Estimation of the noise control cost in dollars per dB for each equipment type. These estimates would be derived from BBN's experience in this type of work;

(c) Inclusion of an escalation index to allow both the number of items of equipment and the cost of noise control to be increased with time, based on the increase in CPI and the economic growth experienced in the particular industry.

7.3 Establishment of a Data Bank

This involves collection of noise level and personnel work assignment data from a selection of plants in all industries which are considered important from a noise exposure viewpoint. The data may be collected over an extended period of time but the data bank can be established early in the work and periodically updated as new data become available. The eventual aim is to allow the evaluation of the exposure problems and approximate costs of compliance in any industry of interest. It is intended that the data bank will exist either on disk file or magnetic tape at the Washington Computer Center. These details are discussed more fully in Section 3 of Appendix B.

7.4 Computer Program Improvements

These improvements, which are designed to extend the usefulness of the program and minimize the complexity in using it, are discussed in detail in Section 3 of Appendix B. The more important extensions to the program are listed below:

(a) Calculation of the effect of the specification of maximum equipment noise levels on certain given equipment types. This will allow the effect of noise control legislation which specifies maximum permitted noise levels, to be evaluated more easily than is possible with the existing program;

(b) Improvement in the accuracy of the extrapolation of results from the entire industry from average results from a small sample of plants. This involves determining the approximate industry population in each personnel category which will require a questionaire to be sent to the majority of plants in a particular industry. The inclusion of more plants in the data sample will also improve the accuracy but collecting the data is a slow process;

(c) Inclusion of the capability of looking at the effect of a four day week or variations thereof on personnel exposure impact.

(d) Finally, it is proposed that the computer program be stored on disc file at the Washington Computer Center and linked with a data bank so that information and data analyses for any given industry can be made available on an interactive basis with the user located at some remote low speed terminal.

Section 8
CONCLUSIONS

Conclusions may be summarized as follows:

1. The computer model which has been developed is a useful tool for estimating personnel noise exposure impacts and equipment contributions to these impacts for individual plants and extrapolating the average results for a randomly selected sample of plants to an entire industry. There are two separate parts to the analysis and results section of the computer program. One produces results in the EPA format (LWP, etc.) and the other produces results in the OSHA formate (DND, etc.). The OSHA part accepts any criteria regarding threshold level, allowable 8-hour level and exchange rate which the user submits. This allows comparison of results obtained using the EPA criterion with any other criterion. The effect of given noise reductions for specified equipment types may also be calculated, either for individual plant results or for the entire industry. This capability is useful for evaluating the effect of any proposed legislation concerning equipment noise levels.

2. The computer model has been used to rank order individual equipment types and general equipment classifications in terms of their effect on the overexposure problem in two industries -- the Sawmill Industry and the Foundry Industry.

3. Personnel categories have also been rank ordered in terms of their importance to the overall noise exposure impact for both the Sawmill and Foundry Industries. The personnel category rank ordering and the equipment rank ordering were calculated using both EPA and OSHA criteria.

4. Results for both personnel exposure impact and equipment noise impact differ depending on whether the EPA criterion

or the OSHA criterion are used in the analysis. In fact the rank ordering of personnel categories in terms of exposure impact and equipment types in terms of their contribution to the exposure impact differes considerably for the two analyses. Reasons for the differences are the different threshold levels (90 dBA for OSHA and 75 dBA for EPA) and the energy exchange in terms of dBA per halving of the exposure time (5 dBA for OSHA and 3 dBA for EPA).

5. The statistical analysis in Section 6 showed that ±20% accuracy for the estimate of the total Level Weighted Population (LWP) is obtained with a sample size of five plants for each industry. The analysis also showed that the LWP and Daily Noise Dose (DND) values extrapolated to the entire industry for each personnel category were estimated with an accuracy of approximately ±50% with the sample size of nine plants for the Sawmill Industry and seven plants for the Foundry Industry. In order to obtain an accuracy of ±20% for these quantities on an industry basis at least 25 plants in each industry would have to be sampled. The computer program uses the variance in the input data to calculate a worst case situation for the LWP and DND values for each category and for the total population when results are extrapolated to the entire industry. The statistical analysis of Section 6 indicates that the worst case values are good estimates of the upper bound for these values.

6. The statistical analysis demonstrated that the accuracy of the Equipment Normalized Priority Index (NPI) values is less than ±50% for the sample size chosen. The NPI values indicate the importance of various equipment types on the exposure of personnel in a given industry. It is shown in Section 6 that at least 30 plants need to be sampled in each industry to obtain an accuracy of ±50% for the NPI value for

each equipment classification and that between 100 and 190 plants need to be sampled for an accuracy of ±20%.

7. The results obtained with the limited sample size used herein are useful in that they indicate which equipment classifications contribute most to personnel exposure in each industry studied (NPI rank ordering) and which personnel categories are most affected by noise overexposure (LWP and DND ordering). The rank ordering may change slightly if more plants are used in the sample, but the changes are not expected to be significant.

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